April 30, 2019

By e-mail only: OSMiningReportsPlans@aer.ca

Alberta Energy Regulator
2nd Floor, Provincial Building
9915 Franklin Avenue
Fort McMurray, Alberta
T9H 2K4

Attention: Charles MacDonald
Mining Authorizations, Manager Oil Sands West

Subject: Tailings Annual Management Report for 2018 – Mildred Lake Site
Syncrude Canada Ltd.
OSCA Commercial Scheme Approval No. 8573 (as amended)

Dear Sir,

The attached report provides information on the 2018 tailings activities, as requested by the Alberta Energy Regulator in the *Fluid Tailings Management Reporting for 2018 – Mildred Lake* letter dated November 15, 2018.

Please contact me if you have any questions regarding this submission.

Regards,

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2018 Mildred Lake Tailings Management Report

Oil Sands Conservation Act Commercial Scheme Approval No. 8573

Submitted to:
Alberta Energy Regulator

Submitted by:
Syncrude Canada Ltd.

April 30, 2019

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1 Introduction

This report is submitted to the Alberta Energy Regulator (AER) in response to the information request as outlined in the *Fluid Tailings Management Reporting for 2018 – Mildred Lake* letter to Syncrude Canada Ltd. (Syncrude) dated November 15, 2018. For reference, a copy of the letter is provided in Appendix B. Table 1-1 below outlines the reporting requirements included in the letter and the sections in this submission which satisfy the requirements.

Syncrude anticipates that future annual reports will be completed in accordance with the requirements outlined in Section 6.2 clause 21 of *Directive 085 – Fluid Tailings Management for Oil Sands Mining Projects*, pending approval of the Mildred Lake Tailings Management Plan (TMP) that was submitted to the AER on April 29, 2016.

Table 1-1 Concordance Table

Requirement	Section
A summary of fluid tailings management activities during the reporting period, including fluid tailings treatment and placement operations, technology development, and contingency or mitigation activities initiated in response to inadequate deposit performance	3
A table showing - the volume and composition of each deposit containing fluid tailings (fluid tailings volumes determined in accordance with Directive 085) - the volume of legacy, new and total fluid tailings for 2016, 2017, and 2018	4
Describe if and how activities have deviated from the fluid tailings management plan and any modifications made to improve performance	3.5
Provide a site-wide water balance or provide the reference to another AER report and location where this information can be obtained	3.4
Provide a water volume (in tabular form) or provide the reference to another AER report and location where this information can be obtained. The table must include, for each treated tailings deposit and fluid tailings pond, - total volume of water at the beginning of the reporting period, - total volume of water at the end of the reporting period, and - the volume and quality of water recovered from fluid tailings	4, 5
Provide information about fines that were not captured, which form fluid tailings, including - quantity of fines in the ore processed during the reporting period, and - quantity of fines in fluid tailings	3.7
Provide a status map of the current locations and sizes of all fluid tailings ponds and treated deposits for the project	3.1
Provide tonnage of ore processed and average composition (bitumen, water, solids) or provide the reference to another AER report and location where this information can be obtained	3.7
For each fluid tailings treatment technology,	

Requirement	Section
- provide volume of fluid tailings treated and where they were placed; - provide expected properties of the treated fluid tailings compared to the actual properties achieved through treatment; and - if the technology is not performing as predicted, provide mitigation measures to rectify performance (address any impacts on the deposit performance)	3.5
For each treated tailings deposit and fluid tailings ponds and their surrounding environment provide monitoring results, including the following: - a map and tabular data showing the survey locations of tailings deposits - representative cross-sections to illustrate the variation of tailings characteristics	4
Description of the treatment technologies' operation over the reporting period, including issues that were encountered and a summary of continuous improvement activities	2, 3
Confirmation that technology development was implemented as proposed in the approved fluid tailings management plan by summarizing relevant activities in the reporting year. Confirm that technology development will continue to be implemented as stated in the approved fluid tailings management plan	3.6
A technical report, within the constraints of proprietary information, on the progress of any pilots, prototypes, or demonstrations of fluid tailings technologies	3.6
An assessment, within the constraints of proprietary information, of performance, successes, challenges, and implications for net environmental effects for all treatment technologies. The assessment may incorporate information references to other required reports, such as the tailings research report and groundwater monitoring report submitted under EPEA	7, 8
To assess operator performance in managing and minimizing environmental effects and implications associated with fluid tailings management activities, the annual management report must provide a summary of the results from environmental performance monitoring reports related to fluid tailings management activities.	6, 7

2 Tailings Treatment Overview

The three tailings technologies included in Syncrude's tailings management plan are composite tailings, FFT centrifugation and water capped tailings, as described below. Syncrude is continuing to research and develop additional tailings technologies, as described in Section 3 of this report.

2.1 Composite Tailings

Composite tailings (CT) technology was first implemented on a commercial scale at Syncrude in the year 2000. To produce CT, tailings are hydraulically pipelined from the extraction facility to the CT plant where they are cycloned to produce a densified Straight Coarse Tailings (SCT) stream. This densified stream (coarse sand) is combined with controlled amounts of fluid fines tailings (FFT) and an amendment additive (i.e. gypsum) to form a non-segregating slurry known as CT. The CT product is then transported hydraulically and deposited either sub-aerially or sub-aqueously into an in-pit tailings deposition area. Sub-aerial deposits consolidate relatively rapidly to form a soft, cappable deposit capable of meeting various land uses and landscape performance goals. Sub-aqueous deposits are expected to consolidate with continued loading and time to achieve a trafficable surface for reclamation. Syncrude has three CT deposits at the Mildred Lake site: East In-Pit (EIP), South West In-Pit (SWIP) and North Mine South Pond West (NMSPW).

2.2 FFT Centrifugation

Syncrude commenced FFT centrifugation technology on a commercial demonstration scale in 2012. The densified FFT product is referred to as cake. FFT is withdrawn by a dredge situated in an existing fluid tailings pond. After initial screening of the FFT, gypsum and a polymer solution are added in the FFT stream and it is fed into a centrifuge. Several centrifuges are utilized in parallel to handle the desired volumes. The rotating speed and angle of the centrifuge control the amount of densification of the tailings. The resulting cake product is then fed onto a conveyor belt to a load out area where the material is transferred into haul trucks which transport the material to the cake deposit. The lighter phase in the centrifuges exits as centrate which is collected and then pumped back to the fluid tailings pond. Cake produced from the FFT centrifugation commercial demonstration was placed in thin lifts at the W1/SWSS cake deposit. In 2015, Syncrude began commissioning a full scale FFT centrifugation plant. This centrifuged cake is being placed in a deep in-pit deposit in North Mine South Pond East (NMSPE).

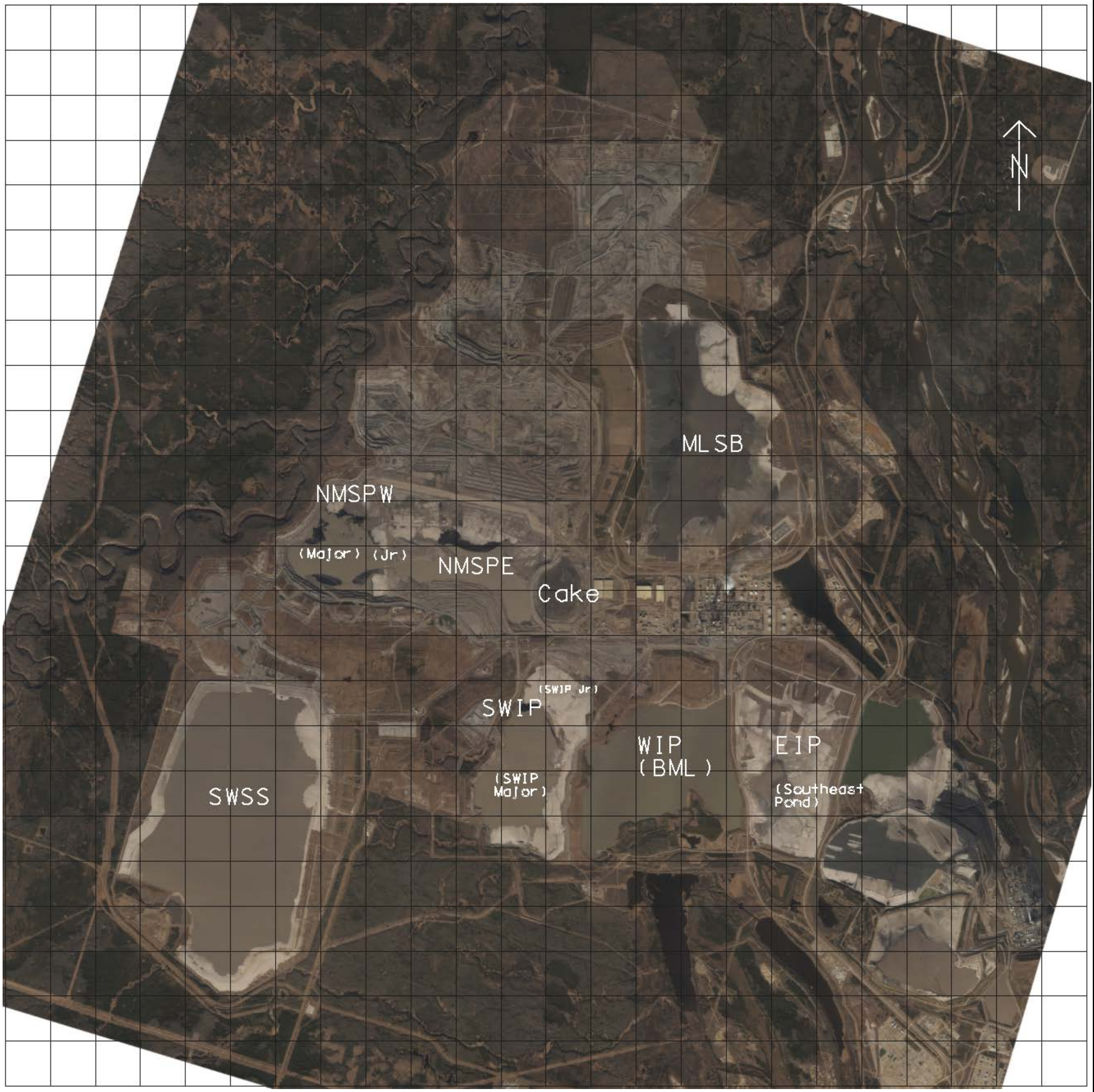
2.3 Water Capped Tailings

The Base Mine Lake (BML) Demonstration Project is an end-pit lake that Syncrude commissioned in 2012. The deposit is now independent from the site tailings systems. In this deposit (formerly called and referred to in this report as West In-Pit or WIP), fluid fine tailings have been capped with several meters of water allowing the FFT to steadily densify over time. Several research initiatives are in place to study the performance of the deposit as it progresses to a functional lake system.

3 Annual Tailings Management Activities

3.1 Deposits

A map of tailings facilities at the Mildred Lake site as of the end of 2018 is shown in Figure 3-1. Table 3-1 provides a summary of the function of each tailings deposit. Table 3-2 shows the surface area for the fluid portion of each of the deposits.



Grid spacing is 1 km by 1 km

		PROJECT: 2018 Tailings Report		
DESIGN		TITLE: **Mildred Lake Tailings Facilities Map**		
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REVIEW				

3.1.1 MLSB

The Mildred Lake Settling Basin (MLSB) is located north of the Syncrude Plant site, bordered to the east by Highway 63 and to the west by the North Mine.

The MLSB was the initial external tailings facility for Syncrude. It provided the only storage for coarse tailings sand, fines and recycle water from 1977 until 1991. The construction of the MLSB facility was completed to its final crest elevation in 1995.

The MLSB provides storage for fluid fine tailings, petroleum coke solids, flotation tailings (Stream 73), froth treatment tailings (Plant 6) and recycle water (RCW). In 2015, the MLSB became the source of FFT and water for the full scale centrifuge plant.

Coke continued to be deposited in the west side of the pond and is transferred from the existing deposit locations via dredge, and placed along the north beach of MLSB.

Plant 6 tailings continued to be deposited in the southeast area of the MLSB. Dredging operations commenced in 2014 and continued through 2018 to create additional volume for Plant 6 tailings deposition.

3.1.2 SWSS

The South West Sand Storage (SWSS) facility is located in the southwest corner of the Mildred Lake lease, approximately 3 km west of the South West In-Pit (SWIP) facility.

SWSS was commissioned in 1991 with three coarse tailings systems and a fluid return system. The facility continued to provide storage for coarse tailings solids and was the source of FFT for the Commercial Demonstration Centrifuge Plant (2012 – 2015).

No coarse tailings were deposited in SWSS in 2018.

3.1.3 WIP (BML)

The West In-Pit (WIP) facility is located within the mined out Base Mine area, immediately west of southbound Highway 63.

WIP was the first in-pit tailings storage facility at Syncrude. Operation of the deposit began in 1995, primarily as a storage facility for fluid fine tailings and recycle water supply for plant operations.

WIP was commissioned as Base Mine Lake (BML) in 2012. The creation of BML has removed the WIP facility from the tailings placement circuit at Syncrude.

3.1.4 EIP

The East In-Pit (EIP) facility is located within the mined out Base Mine area, west of the Suncor lease and bordered by Highway 63 to the east, north, and west, and Gateway Hill to the south.

EIP was commissioned as a tailings storage facility in 1999. It was the primary deposition area for CT upon commercial implementation of the technology in 2000. CT deposition in EIP was complete as of July 2011. The facility has also been a deposition area for coarse tailings. Coarse tailings was deposited in 2018 to support landform construction in preparation for subsequent reclamation material placement. Closure landform shaping was conducted primarily in the east and southern areas of EIP.

A stilling well system was used to collect and pump fluids from the west side of EIP to SWIP Major. To assist in the stilling wells' performance a dredge was also utilized to dredge sand from in front of the stilling wells to provide a deeper channel for fluid transfer in the winter. The dredged sand was transferred and deposited in the southwest end of EIP.

3.1.5 SWIP

The South West In-Pit (SWIP) facility is located within the mined out Base Mine area, west of the WIP facility. SWIP Junior is at the north end of the SWIP deposit and is comprised of a CT and coarse tailings deposit. CT deposition in SWIP Jr. was completed in 2011 and sand capping is now underway in preparation for subsequent closure activities. Fluids from the coarse tailings placement flow into SWIP Major. SWIP Maj. forms the large southern portion of the SWIP deposit. The deposit is utilized for composite tailings and coarse tailings deposition, both of which were placed in 2018. SWIP continues to be a source of recycle water for plant operations and it also provides the FFT supply for the CT plant.

3.1.6 NMSPW

The North Mine South Pond West (NMSPW) deposit is the first tailings deposition area within the North Mine. The deposit is contained by the in-situ pit wall on the south, north and west sides, while the North-South Dyke provides containment on the east side. In 2018, a trench was cut in the NS Dyke with a 287.5 invert in order to connect NMSPW with NMSPE in a controlled manner. This allows NMSPW to remain the same elevation as NMSPE.

A berm separated the deposit and allowed fluids to drain to the west side of the deposit (NMSPW Maj.), while retaining solids on the east side of the berm (NMSPW Jr.). This area started receiving coarse tailings and CT in the fourth quarter of 2013. The beach reached the top of the berm in October 2016.

A fluid transfer system at the south end of NMSPW Major provided RCW return to SWIP and controlled the fluid elevation in the pond. This transfer system was removed in 2018 as the trench through the NS Dyke allows the pond elevation of NMSPW and NMSPE to both be controlled with the NMSPE fluid transfer system.

3.1.7 NMSPE

The North Mine South Pond East (NMSPE) deposit is the second tailings deposition area within the North Mine. NMSPE is contained by the in-situ pit wall on the south and east, the East-West Dyke 1 on the north, and the North-South Dyke on the west. A berm on the east side of the pond separates the deposit into a storage area of centrifuge cake on the east side of the berm and a storage area of coarse tailings on the west side of the berm. The west portion of NMSPE was used for coarse tailings deposition in 2018. NMSPE was connected to NMSPW in 2018 through a trench in the NS Dyke.

A fluid transfer system at the south end of NMSPE provides RCW return to SWIP and controls the fluid elevation in the pond.

3.1.8 NMSPE Centrifuge FFT Deep Cake Deposit

The deep cake deposit portion of the NMSPE facility is separated from the main tailings pond by a berm constructed of overburden material. The deposit is contained by the berm to the west, the sulphur platform and the Ta-Tw Dyke to the east, in situ pit wall to the south and the EW Dyke 1 to the north.

Cake deposition commenced in 2015 when the full scale FFT centrifugation plant was commissioned. The cake material is being deposited by truck into a chute located at the north east corner of the deposit. The general slope of the cake surface is trending from north to south. Cake release water and precipitation runoff flow to the south and are dewatered regularly with a land based pumping system.

3.1.9 W1/SWSS Centrifuge FFT Thin Cake Deposit

The W1/SWSS cake deposit was the first deposit for centrifuge cake on the Mildred Lake site. The cake placed on W1/SWSS was deposited in thin lifts. The deposit received material from the FFT centrifuge commercial demonstration plant from 2012 to 2015. The centrifuge demonstration plant ceased operation in Q4 2015 upon start-up of the full scale centrifuge plant and as such there was no new tailings activities in this area. Deposit monitoring results were provided in the 2014/2015 Tailings Report. Reclamation activities commenced in 2017 and continued in 2018.

Table 3-1 Mildred Lake Tailings Deposit Summary

Facility	Function	Contents
MLSB	- Plant recycle water source - Fluid storage - Solids storage - FFT source for centrifuge plant	- Recycle water - Fluid fine tailings - Froth treatment tailings - Flotation tailings - Petroleum coke - Coarse tailings sand - Centrifuge plant centrate
SWSS	- Solids storage - Temporary fluid storage	- Recycle water - Fluid fine tailings - Coarse tailings sand
WIP (Base Mine Lake)	- Water capped tailings demonstration - Treated tailings deposit	- Fresh water - Recycle water - Sequestered fluid fine tailings
EIP	- Solids storage - Temporary fluid storage - Treated tailings deposit	- Composite tailings - Coarse tailings sand - Recycle water - Fluid fine tailings
SWIP	- Fluid storage - Solids storage - Plant recycle water source - FFT source for CT plant - Fluid tailings treatment	- Recycle water - Coarse tailings sand - Composite Tailings - Fluid fine tailings - CT cyclone overflow
NMSPW	- Fluid storage - Solids storage - Fluid tailings treatment	- Coarse tailings sand - Composite Tailings - Fluid fine tailings - Recycle water
NMSPE	- Solids storage - Fluid storage	- Coarse tailings sand - Recycle water
NMSPE – Deep Cake	- Solids storage - Fluid tailings treatment	- Centrifuged FFT cake
W1/SWSS Cake	- Solids storage - Fluid tailings treatment	- Centrifuged FFT cake

Table 3-2 Mildred Lake Tailings Deposit Size

Deposit	Surface Area[1] (ha)
MLSB	518
SWSS	1,667
WIP (Base Mine Lake)	800
EIP	53
SWIP	362
NMSPW	184
NMSPE	171
NMSPE – Deep Cake	102

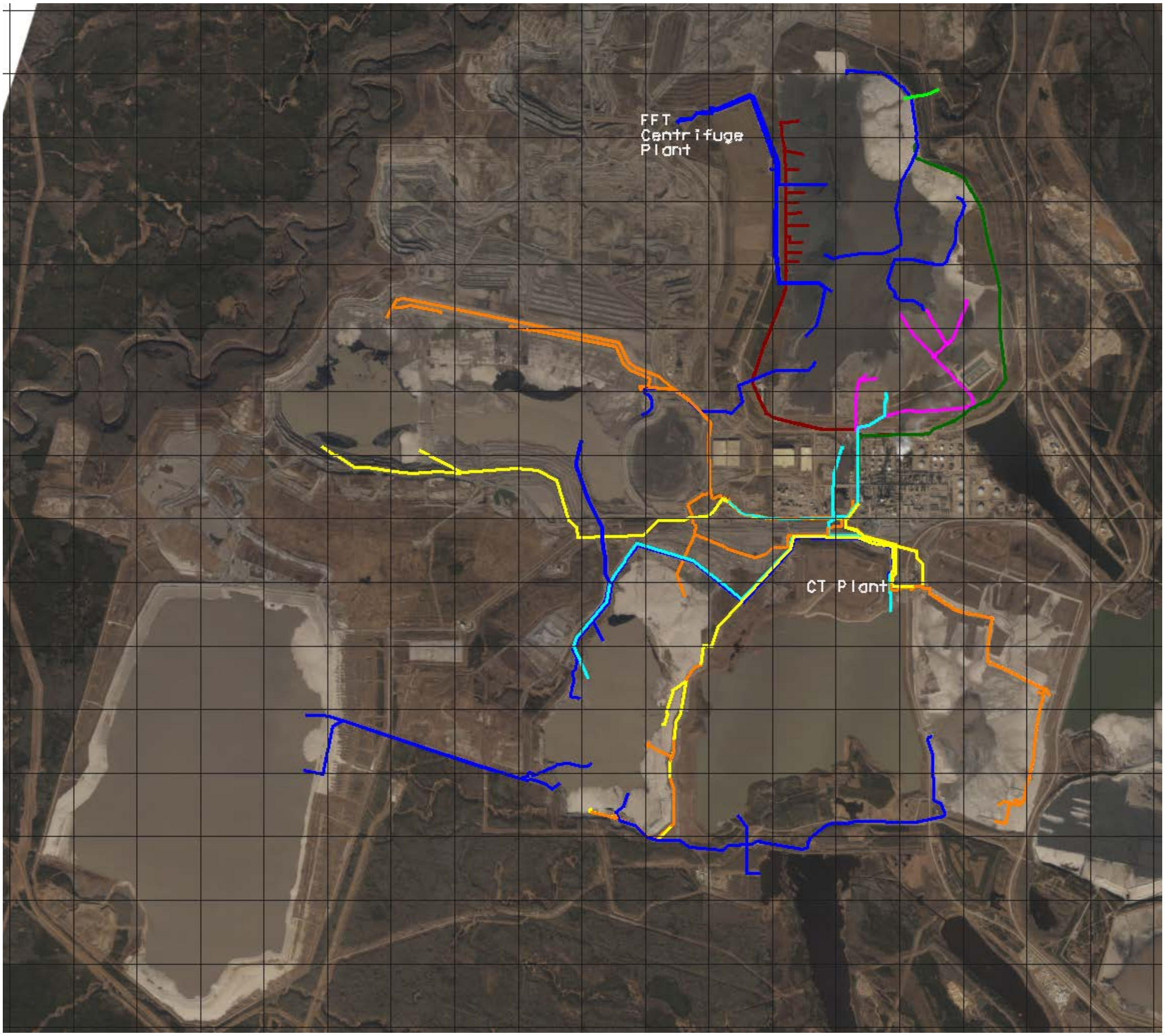
[1] Surface area of fluid portion of pond

3.2 Tailings Line Layout

Site-wide tailing line layouts are provided in Figure 3-2.

Legend:			
Coarse Tailings		Stream 73	
Coarse Tailings / CT		Plant 6	
Fluid Transfer		RCW	
Seepage Line		Coke	
		COF Lines	

1km x 1km grid



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PROJECT: 2018 Tailings Report

TITLE: **Mildred Lake Tailings Line Layout**

SCALE: N/A | REV 0 | **Figure 3-2**

3.3 Industrial Wastewater Control System

Syncrude's industrial wastewater control system consists of:

- An interconnecting network of recycle water ditches, pumps and pipelines which ultimately transport and store the industrial process affected and surface runoff water from plant and mine areas; and
- Active tailings facilities that have sufficient retention time to facilitate settling of solids, allowing water to be recycled for bitumen production operations.

Clarified water recycled from the industrial wastewater control system accounts for a majority (>85%) of Syncrude process water usage. Syncrude water management practices focus on minimizing Athabasca River water diversion, maximizing recycle of process affected water and responsibly managing the storage of process affected water.

An overview of Syncrude's industrial wastewater control systems for the Mildred Lake and Aurora North sites is provided in Figure 3-3. Additional information can be found in section 6 of this report.

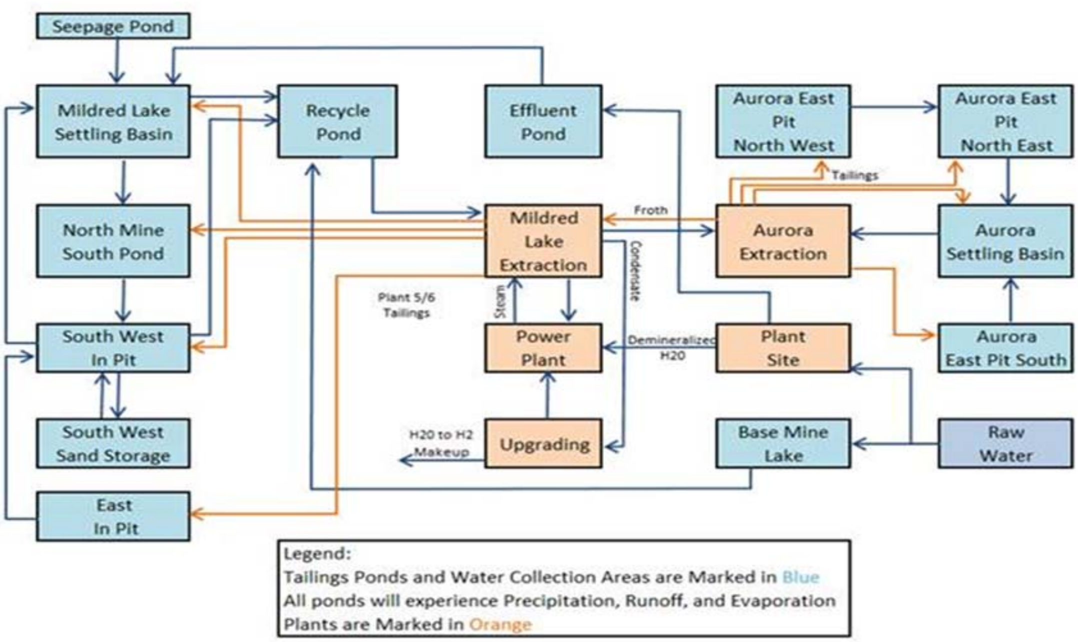


Figure 3-3 Syncrude Industrial Wastewater Control Systems

3.4 Site Water Summary

The Mildred Lake site water balance is provided in Table 3-3.

Table 3-3 Mildred Lake Water Balance

Mildred Lake Site	Mm^3
Inflows	
Water Import from Mildred Lake Reservoir	28.3
Beaver Creek Reservoir Water Import to BML	2.8
Surface and Groundwater	27.9
Water in Froth from Aurora North	5.8
Connate Water	2.8
Total Inflow	67.7
Outflows	
Process Water to Aurora North via Inter-site Pipeline	(19.0)
Losses (Steam, Evaporation, Tailings Pore Water, etc.)	(46.7)
Discharge Water (Surface and Groundwater) to Environment	(2.3)
Total Outflow	(68.0)
Balance	
Change in Inventory	(0.3)
Water Stored in Tailings Ponds at End of 2017 [1]	144.1
Water Stored in Tailings Ponds at End of 2018 [1]	143.8
Balance	**0.0**

[1] Projected from measured volumes to year-end

3.5 Tailings Treatment Summary

3.5.1 Volumes

The annual volume of fluid fine tailings treated and the corresponding volumes of treated tailings deposited is shown in Table 3-4. The CT volume by deposit is shown in Table 3-5.

The FFT feed volume to the CT plant and CT slurry volume are measured using instrumentation. The FFT feed to the CT plant is transferred at approximately 26-33% solids by weight. The CT beach deposit volume is calculated assuming a dry density of 1.42 Tonnes/m^3. The cake volume and FFT feed to the centrifuge plant is calculated using a combination of instrumentation and sampling data.

Table 3-4 Volumes of Treated Fluid Fine Tailings

FFT Feed to CT Plant	Mm³	0.59
CT Slurry Volume	Mm³	3.67
CT Beach Deposit	Mm³	2.11
FFT Feed to Centrifuge Plant	Mm³	7.61
Cake Volume (NMSPE)	Mm³	6.38

Table 3-5 CT Volume by Deposit

NMSPW	Mm³	1.41
SWIP	Mm³	0.70
Total	**Mm³**	**2.11**

3.5.2 Properties

Syncrude's target sand to fines ratio (SFR) for CT is 3-5 units of sand to 1 unit of fines. The actual CT SFR for 2018 was 3.0:1.

In 2018, the average solids content of the cake produced from the FFT centrifugation plant was 54.1% (including bitumen) which is within the targeted range of 50 - 60%.

3.5.3 Challenges and Improvements

In 2018, no significant changes were made to the CT process. CT production was temporarily suspended from the end of June to September due to production restrictions associated with a significant unplanned power outage in the plant. Additionally, CT production was restricted due to prioritizing containment systems to increase tailings containment space.

Many improvements were implemented in 2018 for the FFT centrifugation plant including commissioning of the surge pond to provide a more consistent quality of FFT for the plant, improving the design of the centrifuges to reduce downtime, and control changes to optimize centrifuge operation. Syncrude continues to evaluate potential reliability improvements and plant optimizations.

3.6 Tailings Technology Field Tests, Pilots and Demonstrations

Syncrude is committed to responsible oil sands development, which includes continuous improvement of our environmental performance, meeting or exceeding regulatory requirements and progressively reclaiming the land disturbed by our operation to meet mine closure objectives. In order to ensure the land can be returned to a stable, safe condition that is capable of supporting biologically self-sustaining communities of plants and animals, Syncrude has a dedicated research and development department and specialized state-of-the-art facilities with a significant focus on tailings and reclamation. In fact, Syncrude spends about $30 million towards tailings and reclamation related research per year. Syncrude often undertakes environmental research in collaboration and partnership with academic institutions across Canada and North America.

In addition to internal research and development projects, Syncrude also participates in activities that support regional research initiatives through Canada's Oil Sands Innovation Alliance (COSIA). COSIA is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada's oil sands through collaborative action and innovation. The learnings from Syncrude and COSIA's research initiatives have been and will continue to be leveraged to ensure that the tailings technology options are well understood and can be successfully implemented at Syncrude.

The advancement of tailings technology development is a priority for Syncrude. The following sections provide an overview of the various tailings technology field tests, pilots and demonstrations that Syncrude is actively pursuing.

3.6.1 Base Mine Lake Demonstration

Base Mine Lake (BML) is the first commercial-scale demonstration of the end pit lake technology in the oil sands industry. BML is located in the former West In-Pit (WIP) of the Syncrude Mildred Lake operation. It consists of a mined out oil sands pit filled with fluid fine tailings (silt, clay, process-affected water and residual bitumen) that sits below a combination of oil sands process-affected water and fresh water. This pit lake configuration is often referred to as water capped tailings technology (WCTT). Based on previous research and modelling, the prediction for WCTT is that with time, end of pit lake (EPL) water quality improves and the FFT (or other tailings) will remain physically sequestered below the water cap. Placement of FFT began in 1995, was completed in late 2012, and BML was commissioned as of December 31, 2012. An aerial view of BML is shown in Figure 3-4.

Base Mine Lake monitoring and research began in 2013 and is ongoing. To date, the results from the BML monitoring and research program indicate that the lake is performing as expected and will successfully demonstrate the applicability of water-capped tailings technology. Key findings include the following:

- The FFT mudline is distinct.
- The FFT is settling as expected (up to 6m of settlement between October 2013 and October 2018).
- The water column exhibits conventional boreal lake dimixis.
- Water quality is improving with time.
- A wide variety of biological communities are developing (e.g. algae, zooplankton, macroinvertebrates and macrophytes).
- Residual fines created a turbid water column. The alum dosage in 2016 was successful in clearing the water.
- Bitumen is present in the lake. Several methods of bitumen remediation have been tested, including surface water skimming, dredging and shoreline clean-up. In 2019, dredging bitumen on the FFT surface and booming/skimming bitumen on the water surface are the primary priorities for hydrocarbon mitigation.
- An adaptive management approach to pit lake reclamation is beneficial to steward EPLs toward target outcomes.

Figure 3-4 Base Mine Lake

3.6.2 FFT Accelerated Dewatering Phase 3 (ADW3)

Syncrude continued research on the FFT accelerated dewatering concept by both building upon results from previous studies and evaluating new FFT treatments. Accelerated dewatering technology involves in-line flocculation of FFT (potentially with other additives), followed by surface water management after deposition to promote drying. Syncrude has conducted various stages of research and development involving flocculated FFT accelerated dewatering, beginning with bench scale testing in 2007. In 2009, Syncrude established a 50,000 m^3 accelerated dewatering pilot deposit at the Mildred Lake plant site. In order to continue with the technology development and building upon the learnings of the initial pilot, two new cells (~80m x 80m x 10m depth) were constructed in 2017 (Phase 2) and an additional two cells were constructed in 2018 (Phase 3). Figure 3-5 provides an overview of the various ADW deposits.

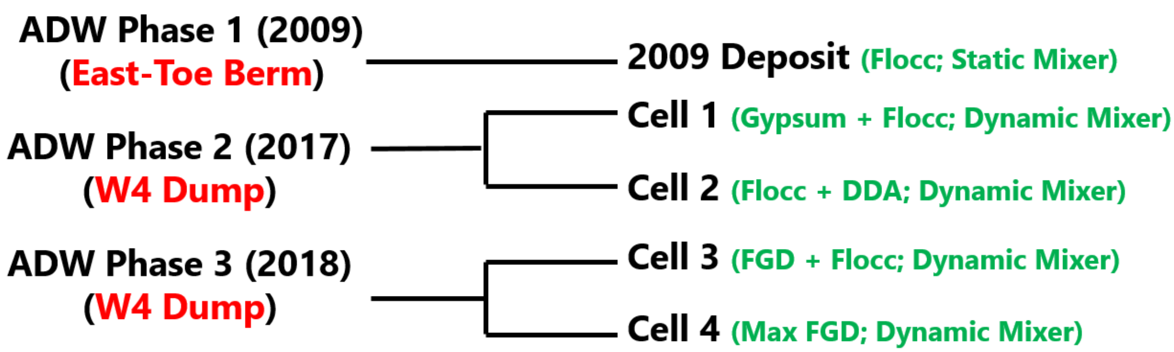


Figure 3-5 ADW Deposit Overview

Using the same basic cell configuration as ADW Phase 2, in 2018 two new ADW treatments were piloted. Cell 3 was filled with FFT pretreated with Syncrude's Flue Gas Desulphurization (FGD) solids, followed by flocculation using the same flocculant mixer configuration used to fill cell 1. Cell 3 is a match for cell 1 except that Syncrude FGD solids was used instead of gypsum as the FFT pretreatment. Cell 4 was filled with an FFT treated with FGD solids alone, based on the laboratory results that preceded the initial ADW pilot in 2009. The coagulant only FFT treatment in cell 4 does not have the significant initial water release associated with the polymer treatments, but there is a potential for better long term consolidation. The settling and consolidation behaviour of these test cells will provide a very complete picture of ADW performance. In addition, they will provide an important comparison to centrifuge cake consolidation since the treatments used in cells 1 and 3 are the same treatments that have been evaluated in the FFT centrifuge plant.

Figure 3-6 shows the 2017 Phase 2 field pilot test facilities with two inline dynamic mixers. The configuration was identical for filling cell 3, with only mixer 1 used for the polymer mixing. Figure 3-7 shows the cell configuration for cell 2 which is identical to cells 3 and 4 in the present pilot program. Monitoring of the 2018 deposition cells and comparisons to previous ADW deposits will be ongoing into 2020.

Figure 3-6 ADW Phase 2 Test Facilities

Figure 3-7 Example Cell from ADW Phase 2 and Phase 3

3.6.3 FFT Overburden Clay Treatment (Co-Mixing)

Syncrude is continuing to further develop the FFT overburden clay treatment (co-mixing) technology. Co-mixing involves the co-disposal of FFT by mixing it into over-consolidated clayey overburden material (Kc) from the Clearwater benches of the oil sands mine pits. The process involves solidifying FFT by absorbing process affected water into clay lumps, resulting in unsaturated soils of predictable strengths. The premise of co-mix is that it could be feasible to combine significant quantities of FFT with Kc clays, which are mined as part of the normal overburden pre-strip operation. These mixtures can then be placed into large deposits which become geotechnically stable, trafficable, and that will typically be reclaimed as terrestrial landscape features.

A number of co-mixing laboratory and field tests have been conducted since 2012. In order to further develop this technology, in October 2018 Syncrude conducted a small scale field prototype on the W4 overburden facility. In this test, the FFT was first pumped into the co-mix deposit and the overburden material was then added to the deposit using excavators. Based on the previous co-mix deposit tests, a ratio of 2.1 overburden to 1 FFT was kept for the deposit in order to achieve roughly 72.5% solid contents. The volume of the co-mix within the test cell was roughly 1,130 m^3 of FFT and 2,689 m^3 of overburden material.

Figure 3-8 shows the constructed cell before filling, Figure 3-9 shows the cell filled with FFT to the design elevation, Figure 3-10 shows an excavator casting overburden into the cell and Figure 3-11 shows the cell one day after filling is completed. The test cell will be sampled as part of the 2019 Mildred Lake tailings deposit measurement plan.

Figure 3-8 2018 FFT Co-Mixing Test Cell – Before Filling

Figure 3-9 2018 FFT Co-Mixing Test Cell – FFT Filling

Figure 3-10 2018 FFT Co-Mixing Test Cell – Overburden Casting

Figure 3-11 2018 FFT Co-Mixing Test Cell – After Filling

To further advance the development of the FFT overburden clay treatment (co-mixing) technology, Syncrude is planning a large scale field demonstration at the Mildred Lake plant site in 2019, which would treat roughly 800,000 m^3 of FFT.

3.6.4 Tailings Co-Deposition

Tailings co-deposition is the placement of two or more tailings products in one area with limited to no deliberate mixing. Syncrude has performed two phases of laboratory scale tests to study the co-deposition of several different combinations of tailings products. Phase 1 was completed in 2017 and Phase 2 was completed in 2018. The tests were conducted in 4.5m x 2.5m x 0.5m flumes, as depicted in Figure 3-12.

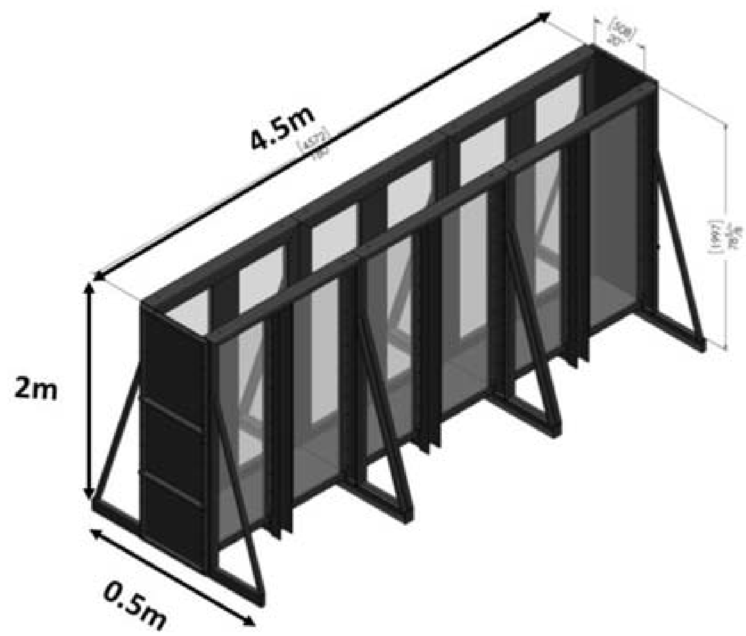


Figure 3-12 Flume Overview

Combinations yielding positive results are currently being considered for field level testing. One of the flume test scenarios that has been identified with applicability for field testing at Aurora North is the co-deposition of flocculated FFT (fFFT) and CT. For this flume test, FFT/RCW was initially poured into the flume to simulate an existing tailings pond and then fFFT and CT were simultaneously deposited into separate ends of the flume, as shown in Figure 3-13.

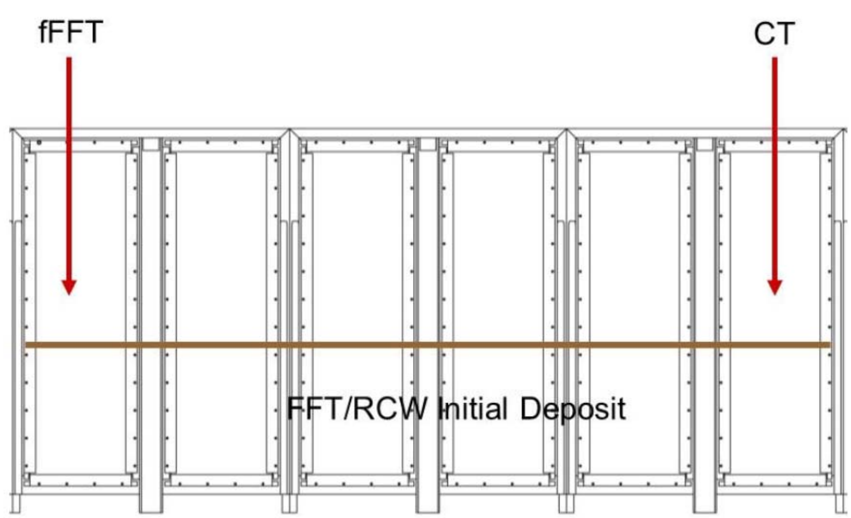


Figure 3-13 Flocculated FFT and CT Flume Test Overview

Figure 3-14 depicts the flume test 17 days after filling. The fFFT/CT flume test observations indicate that:

- The fFFT and CT dewatered and gained strength.
- Minimal mixing occurred at the fFFT / CT interface.
- The fFFT and CT continued to slowly settle and consolidate with time.

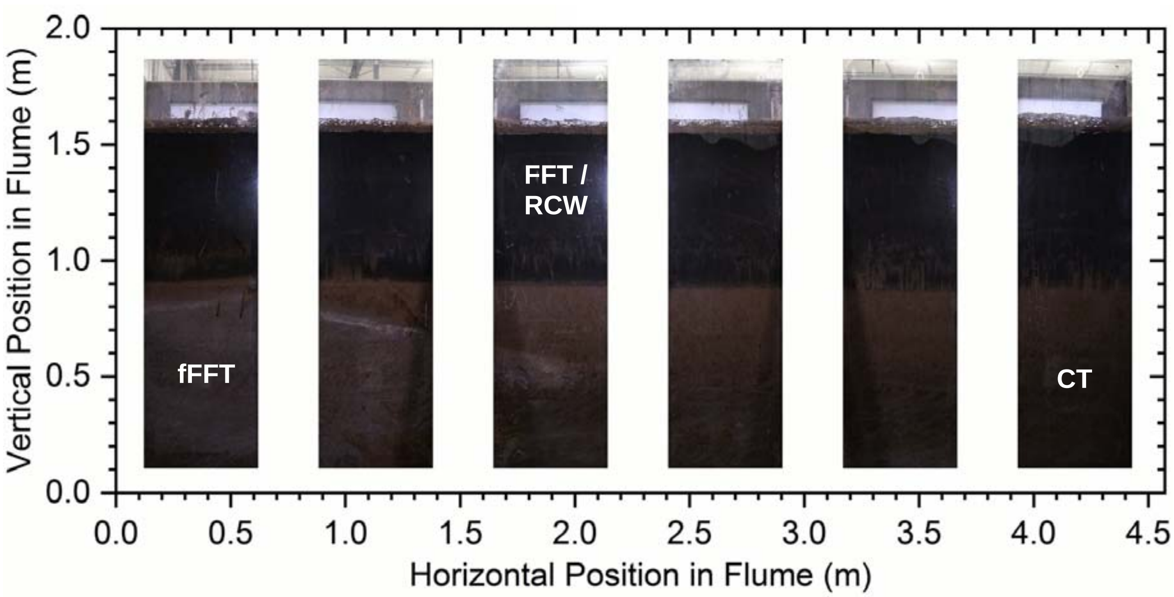


Figure 3-14 Flocculated FFT and CT Co-Deposition Flume Test

To continue development of this concept, Syncrude is evaluating options for a field pilot in 2019. This field pilot would expand on the knowledge gained from the co-deposition flume tests, the previous accelerated dewatering pilots utilizing fFFT and the experience gained from years of CT production. The objective of the field pilot will be to observe the CT and fFFT co-deposit formation and long term performance in an unconstrained flow condition to determine the applicability of the technology at a larger scale.

3.6.5 FGD Solids as a Tailings Treatment Process Aid

The Syncrude Emissions Reduction Project (SERP) utilizes lime or calcium oxide to capture sulphur dioxide gas and minimize air emissions. The process produces a solid product containing calcium sulphite and residual lime, with smaller proportions of petroleum coke and gypsum. These FGD solids have the potential to replace the gypsum that is currently being purchased for use in the production of CT and FFT centrifuge cake, since lime is a proven effective tailings process aid. Substituting Syncrude's FGD solids for gypsum has the added benefit of minimizing the volume of waste being landfilled.

Syncrude has been researching the applicability of utilizing the SERP FGD solids as a replacement for gypsum for several years. In 2016, a preliminary laboratory test program was conducted to confirm the suitability of FGD solids in the CT process. The results from the preliminary study demonstrated that:

- The FGD solids are a suitable substitute for gypsum in the CT process.
- The chemistry of the FGD solids is consistent enough to be used as a viable substitute for gypsum in the CT process.
- The smaller particle size distribution of the FGD solids indicate that it would be superior compared to gypsum in terms of dissolution time.
- The release water chemistry is not adversely affected.

In 2017, a field test was conducted to determine the suitability of FGD solids in the FFT centrifugation process. The concept for field testing Syncrude’s FGD solids in the FFT centrifugation process was based upon learnings from laboratory work conducted previously by Syncrude which showed that FGD solids could be a suitable replacement for gypsum in the CT process. The results from the field test demonstrated that:

- FGD solids are a suitable substitute for gypsum in the FFT centrifugation process
- The polymer performance is not impacted by the FGD solids.
- The difference in particle size distribution and chemistry of the FGD solids did not inhibit the performance of the centrifuges.
- The centrifuge cake that was produced during the test was within the targeted range for solids content.
- The centrifuge cake that was produced during the test was lower in total dissolved salts than when treated with gypsum, indicating that long term reclamation performance could be improved.
- The chemistry of the centrifuge cake and centrate showed lower sulphate concentrations with the addition of FGD solids as compared to gypsum.

A subsequent longer term field test using FGD solids as a replacement for gypsum in the FFT centrifugation plant is planned to commence at the Mildred Lake site in 2019. Syncrude also plans to complete a field test using FGD solids as a replacement for gypsum in the CT plant in 2019. The results from these field tests are expected to further demonstrate that Syncrude’s FGD solids are a suitable substitute for gypsum.

3.6.6 Pilot Test Deposits Monitoring

The various pilot test deposits that have been created by Syncrude Research and Development continued to be monitored throughout 2018. These test deposits were created to observe and measure their long-term geotechnical and geochemical performance in order to reconcile their individual process conditions (such as chemical treatment, mixing, dosage, etc.) to field performance and compatibility with final reclamation and closure objectives. The monitoring activities are focused on tracking the geotechnical trajectory of the deposits as well as the evolution of the water chemistry of the deposits with time. The pilot test deposits that were monitored in 2018 include:

- 2009 Accelerated Dewatering (ADW Phase 1)
- 2010 6m Gypsum cake culvert
- 2014 10m deep centrifuge cake columns
- 2017 ADW Phase 2 (Cells 1-2)
- 2018 ADW Phase 3 (Cells 3-4)

The monitoring activities completed in 2018 included measuring the climatic, geotechnical and geochemical parameters of the deposits.

The climatic monitoring involves in-situ measurement of climatic parameters such as:

- Air temperature
- Air relative humidity
- Wind speed
- Tailings surface temperature and albedo
- Solar radiation

The above parameters are required in the estimation of the potential and actual evaporation rates from the test deposits. These are required to understand the drying potential and drying performance of the tailings deposits, respectively. They also provide inputs into the deposit water balance.

The geotechnical observations included in-situ measurement of tailings parameters such as:

- Settlement
- Pore-pressure
- Temperature
- Total stress
- Water content
- Matric suction

These parameters provide information regarding the evolution of the physical state of the test deposits so the impacts of dewatering drivers such as atmospheric drying, self-weight consolidation and under-drainage can be well understood.

The geochemical monitoring entails tracking the water chemistry of the surface run off and pore water of some of the test deposits that are exposed to the elements. This was accomplished by taking the respective water samples once or twice a year and completing laboratory analyses for various water chemistry parameters.

In addition to the above in-situ measurements, profile sampling and testing of some of the test deposits (ADW Phase 2 and Phase 3) were completed in 2018. Full profile samples of the test deposits were taken and the samples were analyzed for parameters including:

- Dean Stark for Oil Water Solids
- Particle size distribution
- % solids content by oven drying

At the same time the profile samples were taken, ball cone penetrometer tests (BCPT) and vane shear tests (VST) were also completed for the full profile of the test deposits. These tests were aimed at determining the undrained shear strength profiles of the deposits so that the dewatering performance of the deposits quantified from the monitoring instruments can be directly correlated to the physical state of the test deposits obtained from profile samples and strength testing.

3.7 Ore Body Information

The ore body and fines capture summaries are provided below in Tables 3-6 and 3-7, respectively.

Table 3-6 Ore Body Information

Tonnage of Ore Processed	77,373,260
Average Bitumen	10.13%
Average Water	3.84%
Average Mineral Solids	86.03%

Table 3-7 Fines Capture Information

Fines in Ore Processed	20.6 Mt
Fines in New Fluid Tailings	10.5 Mt

4 Deposit Monitoring Results

4.1 Fluid Volumes

The volumes reported in Tables 4-1 and 4-2 show the mid-year survey volumes. For consistency with future reports, beginning in 2018 the volumes are reported as measured rather than projected to year-end.

Table 4-1 Fluid Tailings Volumes

Facility	As Measured FT Volume[1] (Mm^3)
MLSB	141.2
SWSS	116.3
WIP	172.9
EIP	1.3
SWIP Major	43.6
NMSPW	18.1
NMSPE	7.3
NMSPE Deep Cake	13.9
Total	**514.6**

1. Fluid tailings volumes at times of deposit measurement in 2018

Table 4-2 Tailings Deposit Water Volumes

Facility	Beginning of reporting period[1] (Mm^3)	End of reporting period[2] (Mm^3)
MLSB	7.5	8.3
SWSS	48.4	43.9
WIP	63.6	67.1
EIP	0.7	0
SWIP Major	19.2	14.6
NMSPW	0.6	6.2
NMSPE	4.1	7.4
NMSPE Deep Cake	0	0
Total	**144.1**	**147.5**

1. Water volume at end of 2017
2. Water volumes as measured at time of deposit sampling in 2018

Table 4-3 Accounting Table

Year	Previous Year New FT Inventory	Previous Year Legacy FT Inventory	Fluid Tailings Inventory [1]	Change in New FT Inventory	Change in Legacy FT Inventory	New FT Inventory	Legacy FT Inventory	Submitted Profile New FT Inventory	Submitted Profile Legacy FT Inventory	New FT Rolling Profile Deviation % Difference	Legacy FT Rolling Profile Deviation % Difference
2014	----	----	----	----	----	0.0	469.6	0.0	469.6	----	----
2015	0.0	469.6	472.6	15.8	-12.8	15.8	456.8	14.6	461.7	8%	-1.1%
2016	15.8	456.8	494.8	31.1	-8.9	46.9	447.9	31.1	449.0	29%	-0.7%
2017	46.9	447.9	483.1	-1.2	-10.4	45.6	437.5	54.3	433.1	14%	-0.1%
2018	45.6	437.5	492.3	19.6	-10.5	65.2	427.1	71.4	417.9	8%	0.5%

All volumes are in millions of cubic metres

1 - Non-RTR Fluid Tailings

4.2 Deposit Sampling

Cross-sections are illustrated in Figures 4-1 to 4-26 for the following deposits and parameters:

- MLSB:
  - Sampling and Measurement Locations
  - Zone Interfaces
  - % Solids

- SWSS
  - Sampling and Measurement Locations
  - Zone Interfaces
  - % Solids

- EIP
  - Sampling and Measurement Locations
  - Zone Interfaces
  - SFR
  - % Solids

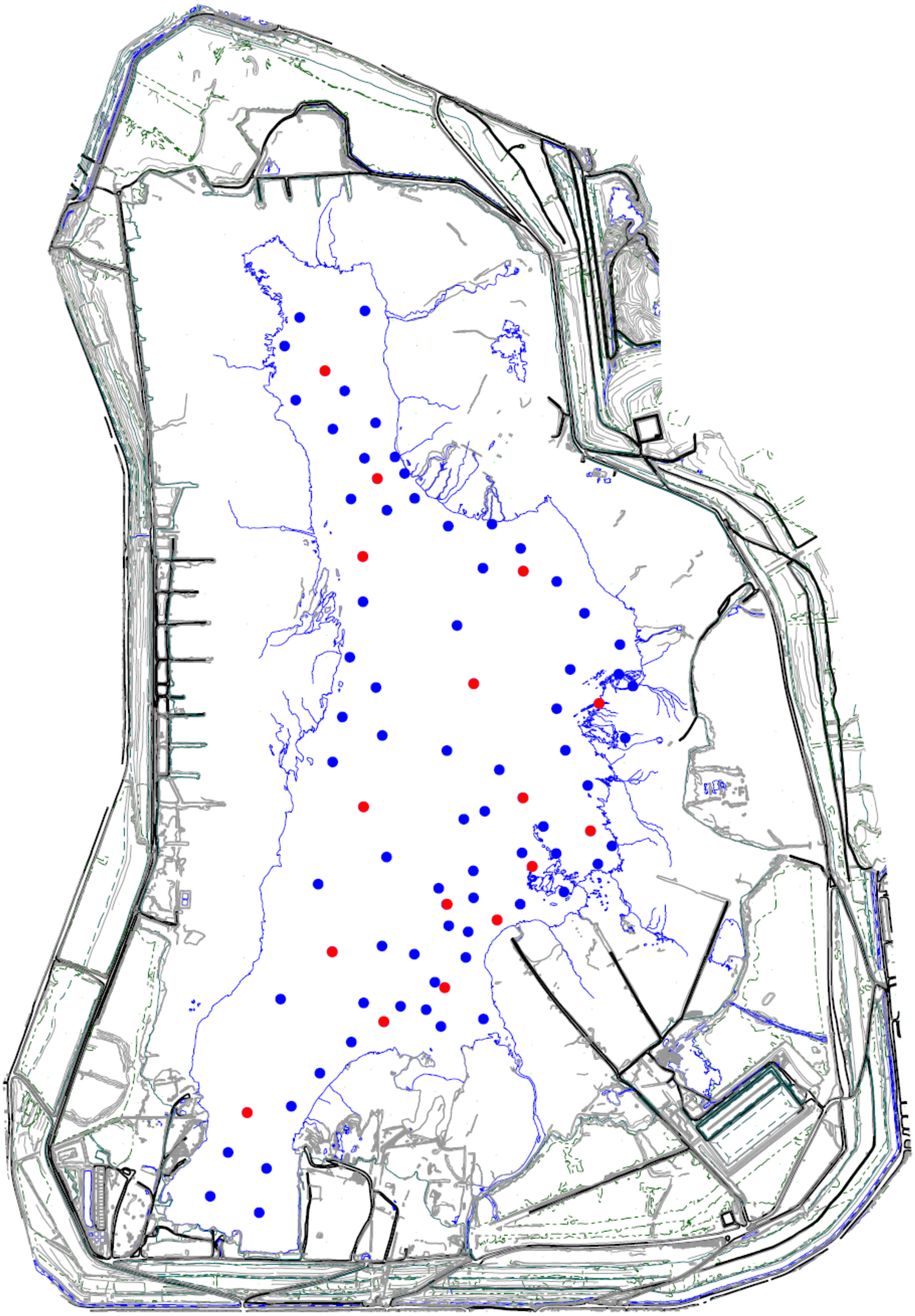
- SWIP
  - Sampling and Measurement Locations
  - Zone Interfaces
  - SFR
  - % Solids

- NMSPW
  - Sampling and Measurement Locations
  - Zone Interfaces
  - SFR
  - % Solids

- NMSPE
  - Sampling and Measurement Locations
  - Zone Interfaces
  - % Solids

- NMSPE Deep Cake
  - Sampling and Measurement Locations
  - % Solids

4.2.1 MLSB



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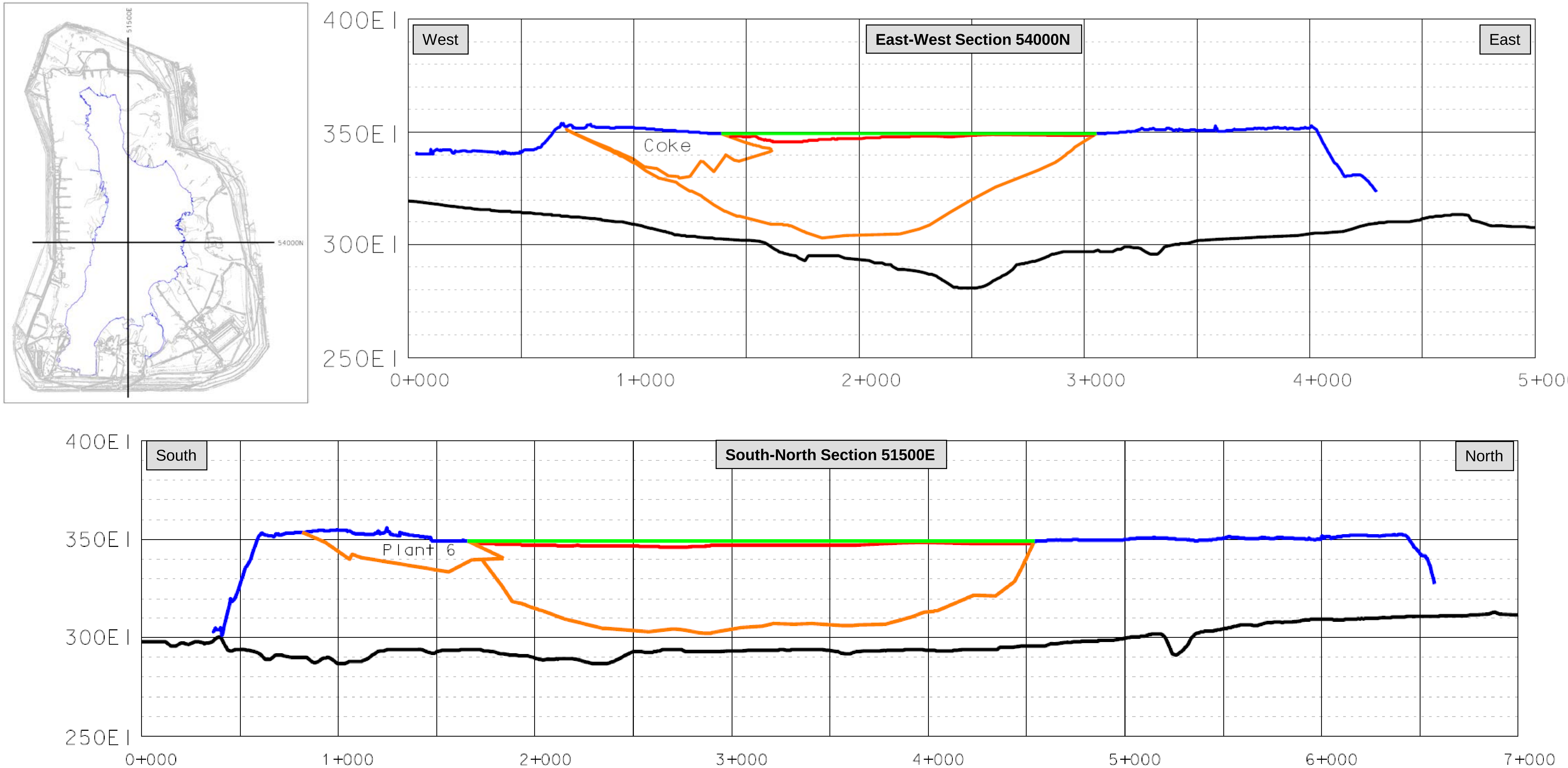
PROJECT:
2018 Tailings Report

TITLE:
MLSB Sampling and Measurement Locations

SCALE: N/A	REV 0	**Figure 4-1**



Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (April 2018)
- Pre-Tailings Deposition Surface

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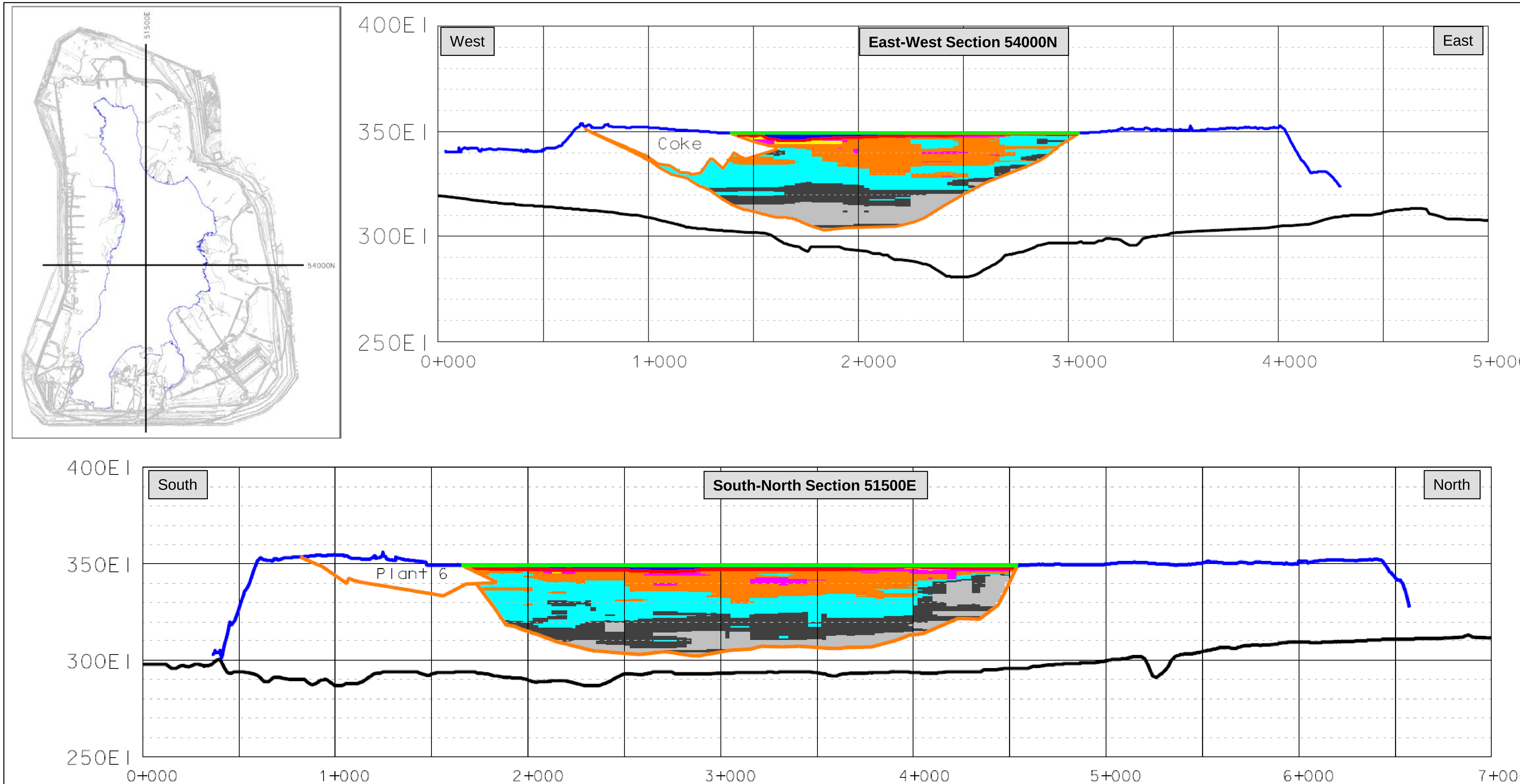
PROJECT: 2018 Tailings Report

TITLE: **MLSB Fluid Tailings Cross Sections with Zone Interfaces**

SCALE: 10x Vertical Exaggeration	REV 0	**FIGURE 4-2**



Legend - Percent Solids

- 0.00 - 5.00
- 5.00 - 10.00
- 10.00 - 20.00
- 20.00 - 30.00
- 30.00 - 40.00
- 40.00 - 50.00
- 50.00 - 60.00
- 60.00 - 70.00
- 70.00 - 80.00
- 80.00 - 90.00
- 90.00 - 100.00

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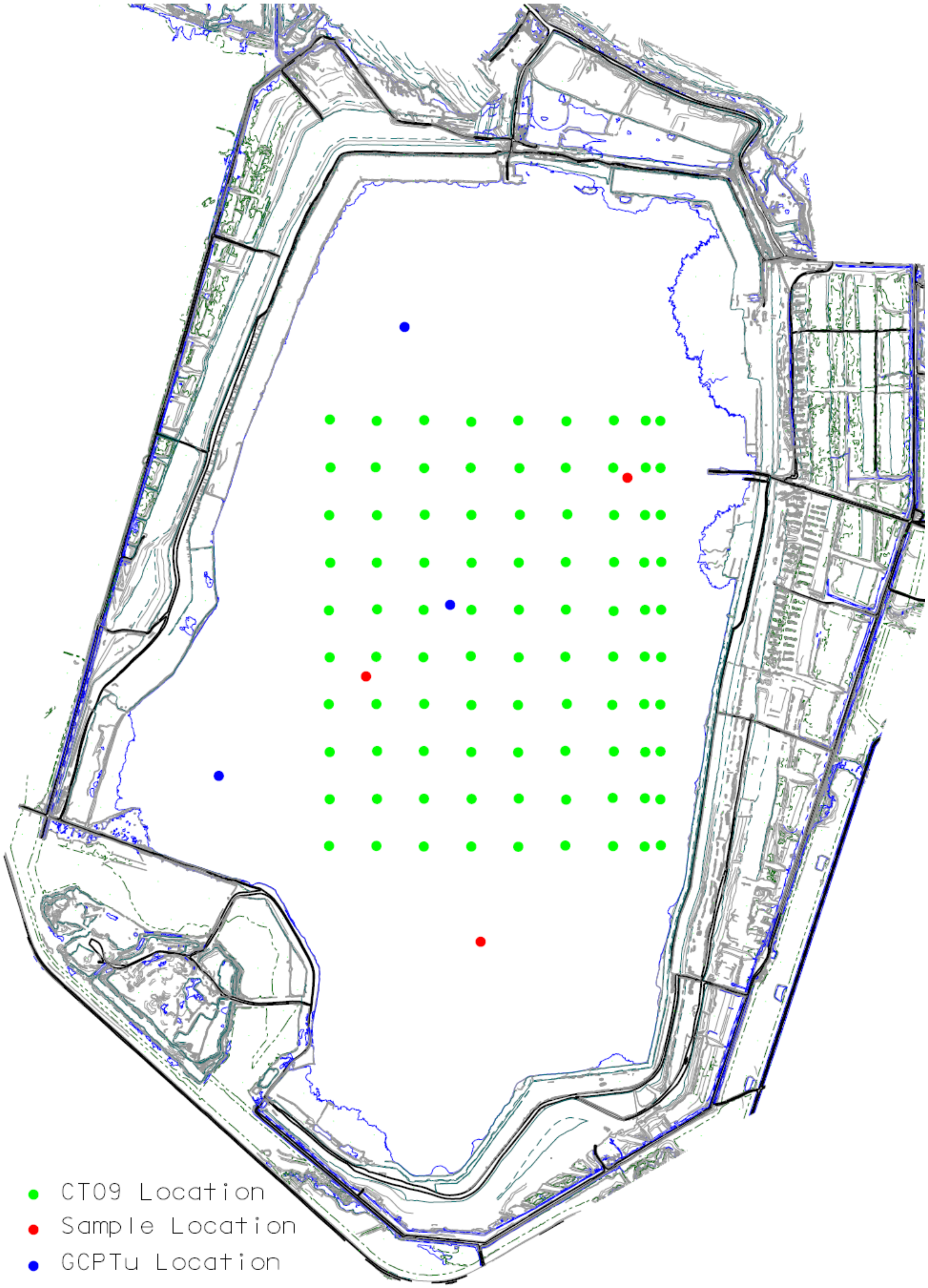
PROJECT: 2018 Tailings Report

TITLE: **MLSB Fluid Tailings Cross Sections by % Solids**

SCALE: 10x Vertical Exaggeration | REV 0 | **FIGURE 4-3**

4.2.2 SWSS



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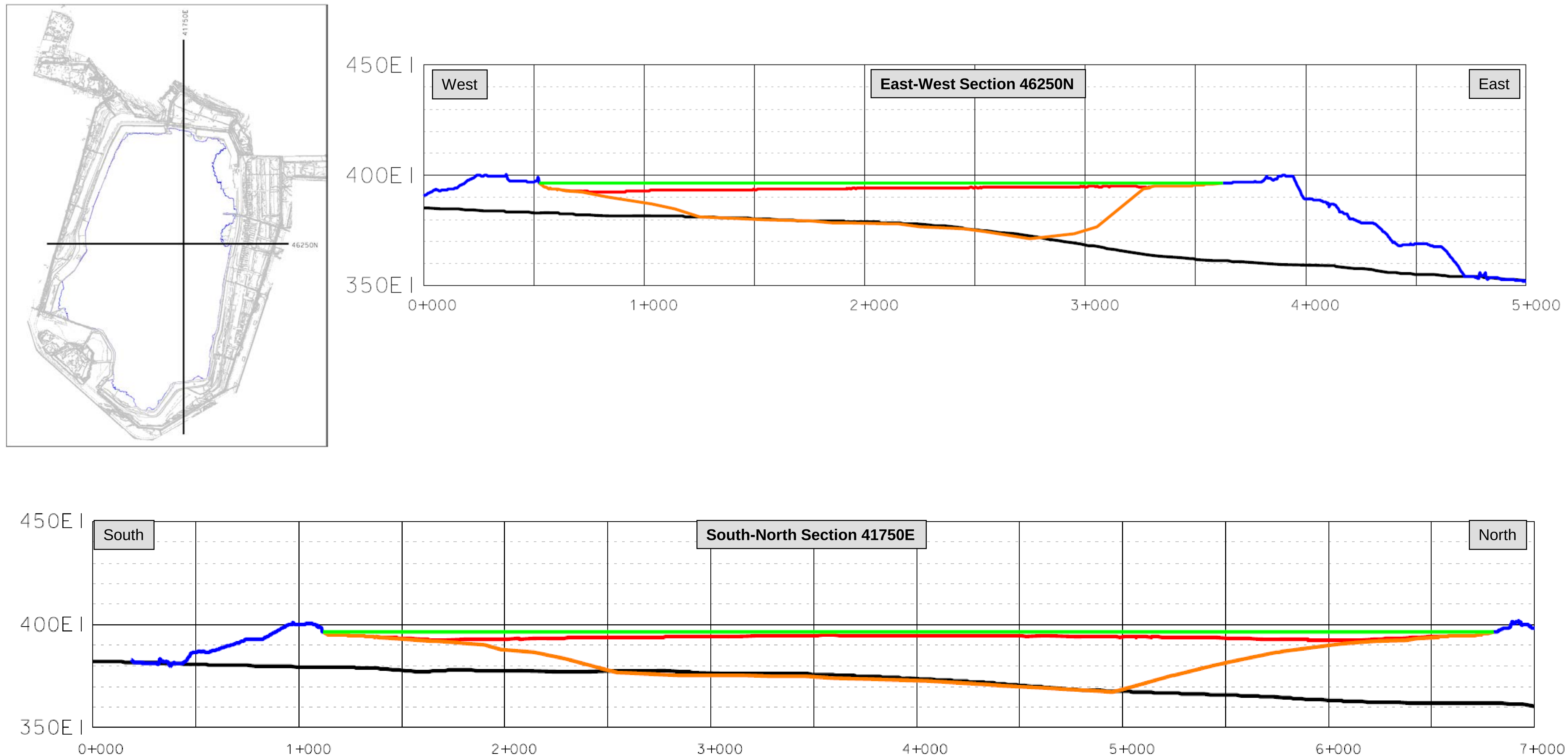
PROJECT: 2018 Tailings Report

TITLE: **SWSS Sampling and Measurement Locations**

SCALE: N/A | REV 0 | **Figure 4-4**



Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (August 2018)
- Pre-Tailings Deposition Surface

Syncrude

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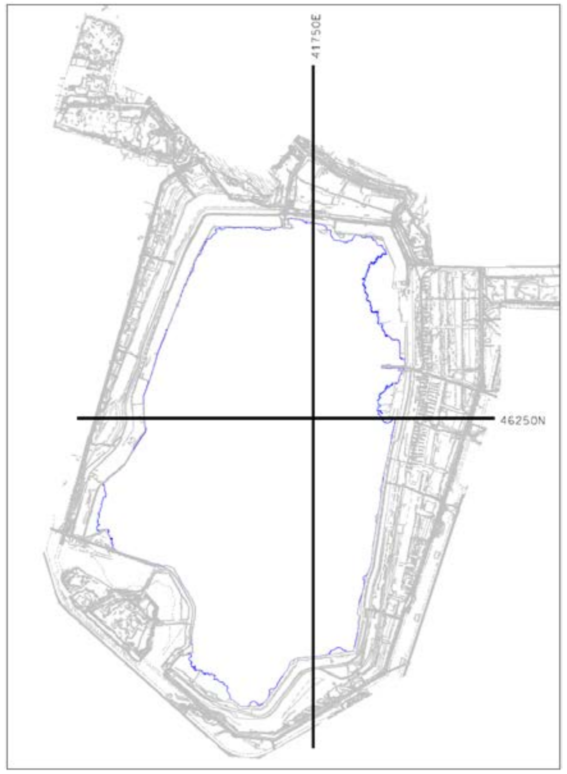
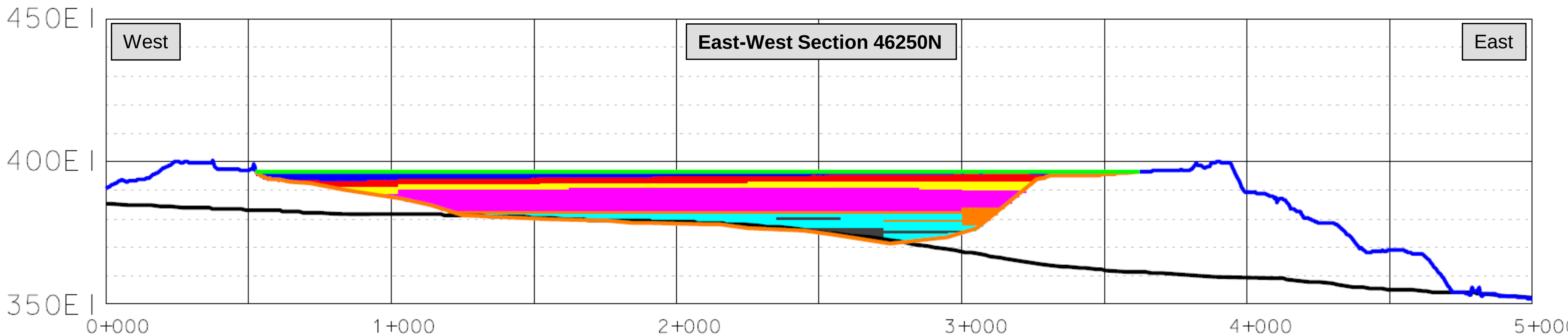
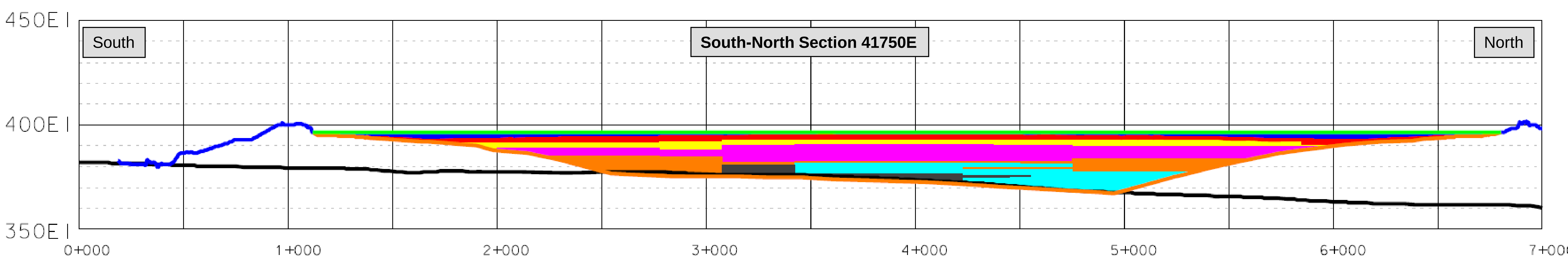
PROJECT: 2018 Tailings Report

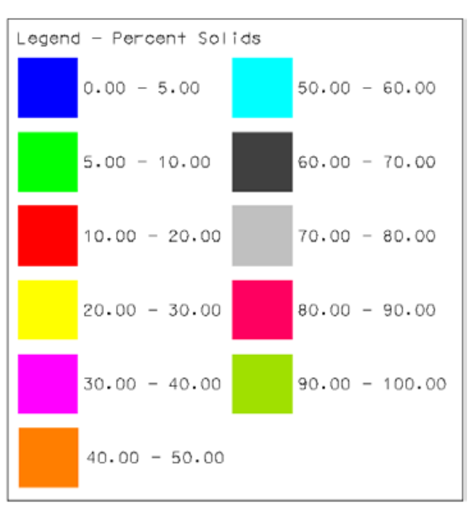
TITLE: **SWSS Fluid Tailings Cross Sections with Zone Interfaces**

SCALE: 10x Vertical Exaggeration	REV 0	**FIGURE 4-5**









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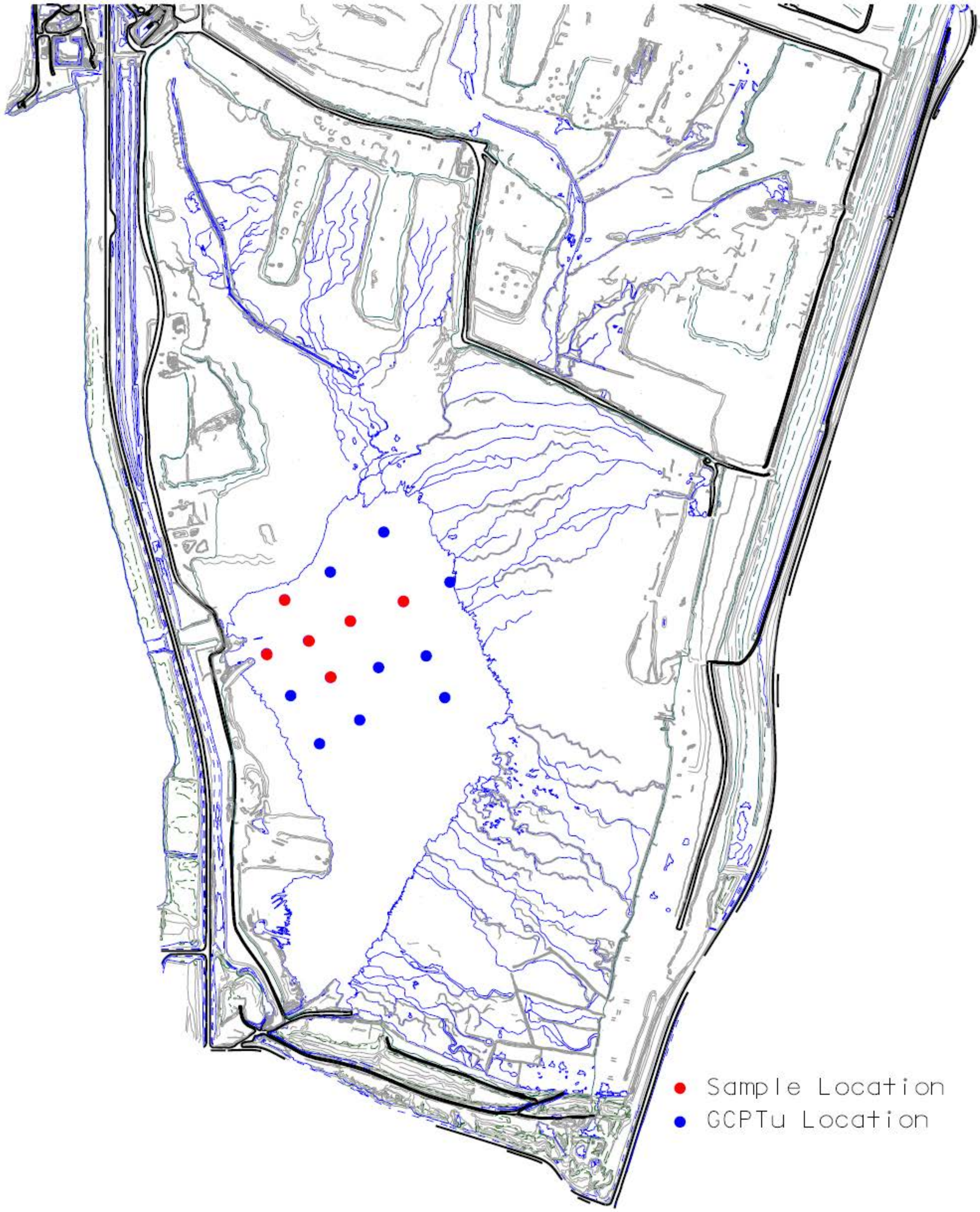
PROJECT: 2018 Tailings Report

TITLE: **SWSS Fluid Tailings Cross Sections by % Solids**

SCALE: 10x vertical exaggeration | REV 0 | **FIGURE 4-6**

4.2.3 EIP



Syncrude

PROJECT:

2018 Tailings Report

TITLE:

EIP Sampling and Measurement Locations

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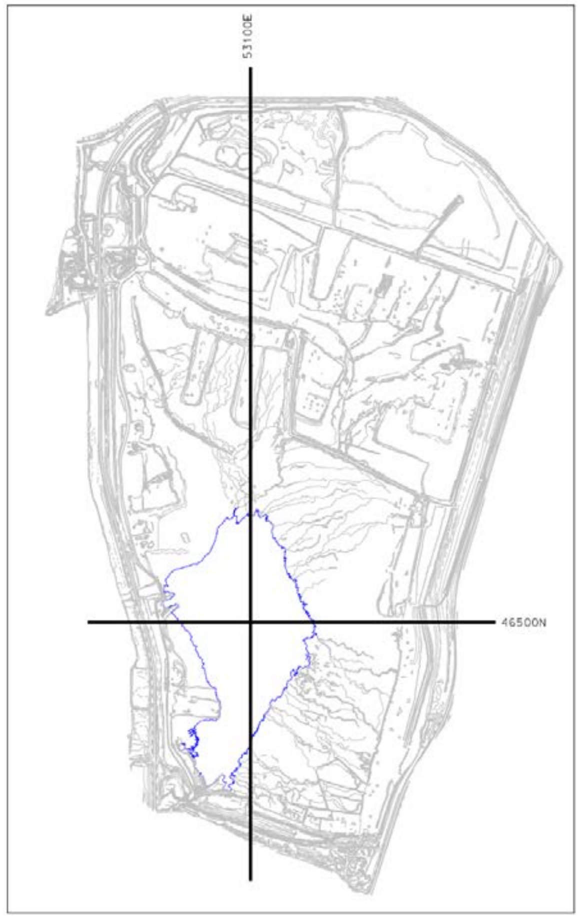
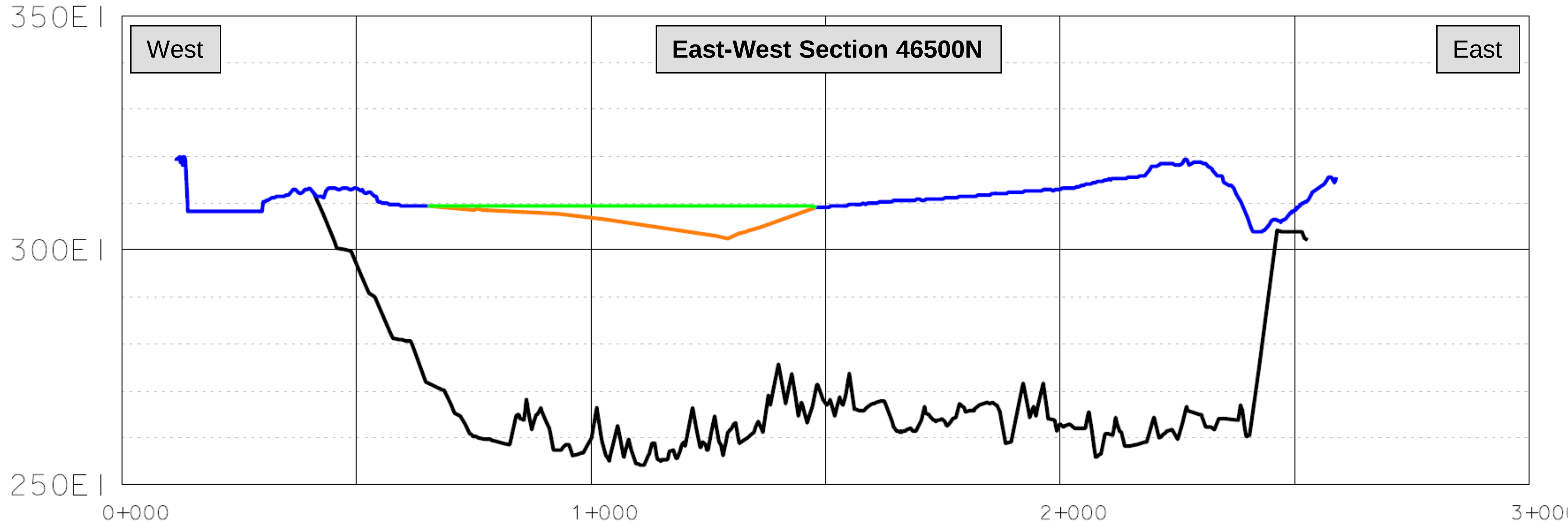
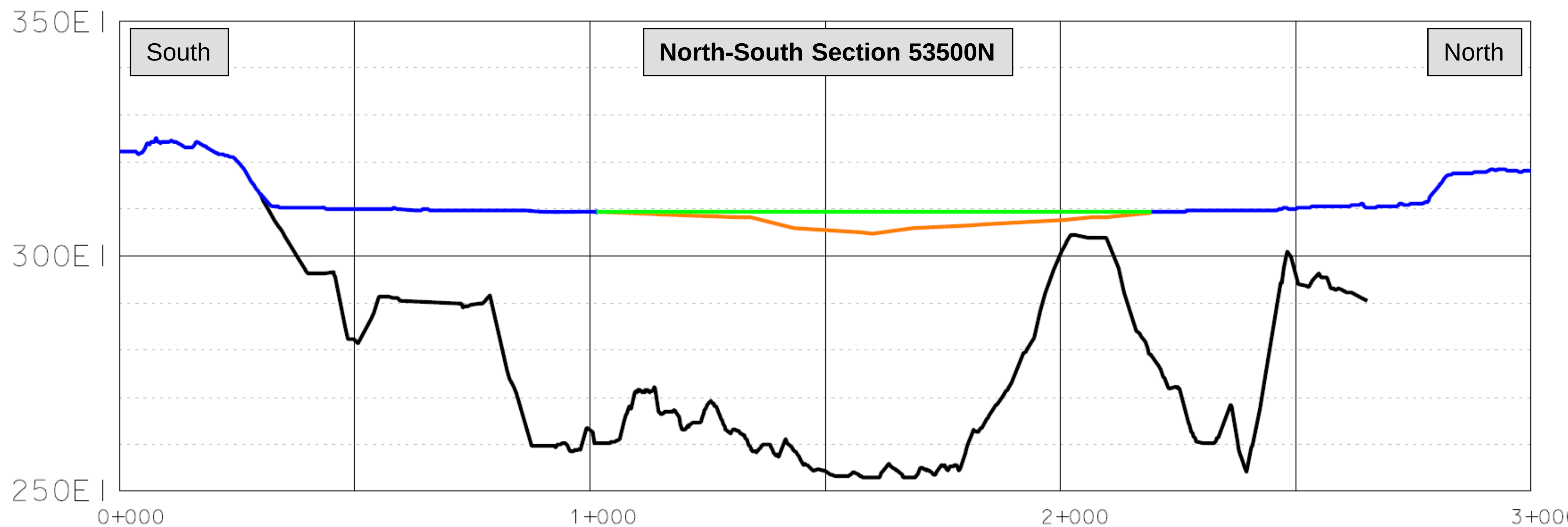
SCALE: N/A | REV 0 | **Figure 4-7**







Legend
- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (May 2018)
- Pre-Tailings Deposition Surface

Syncrude

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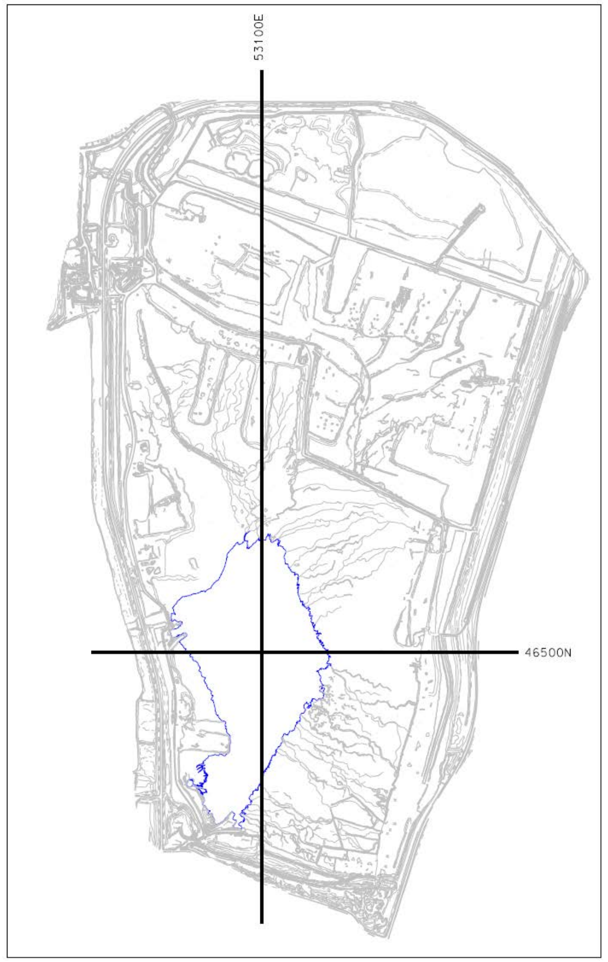
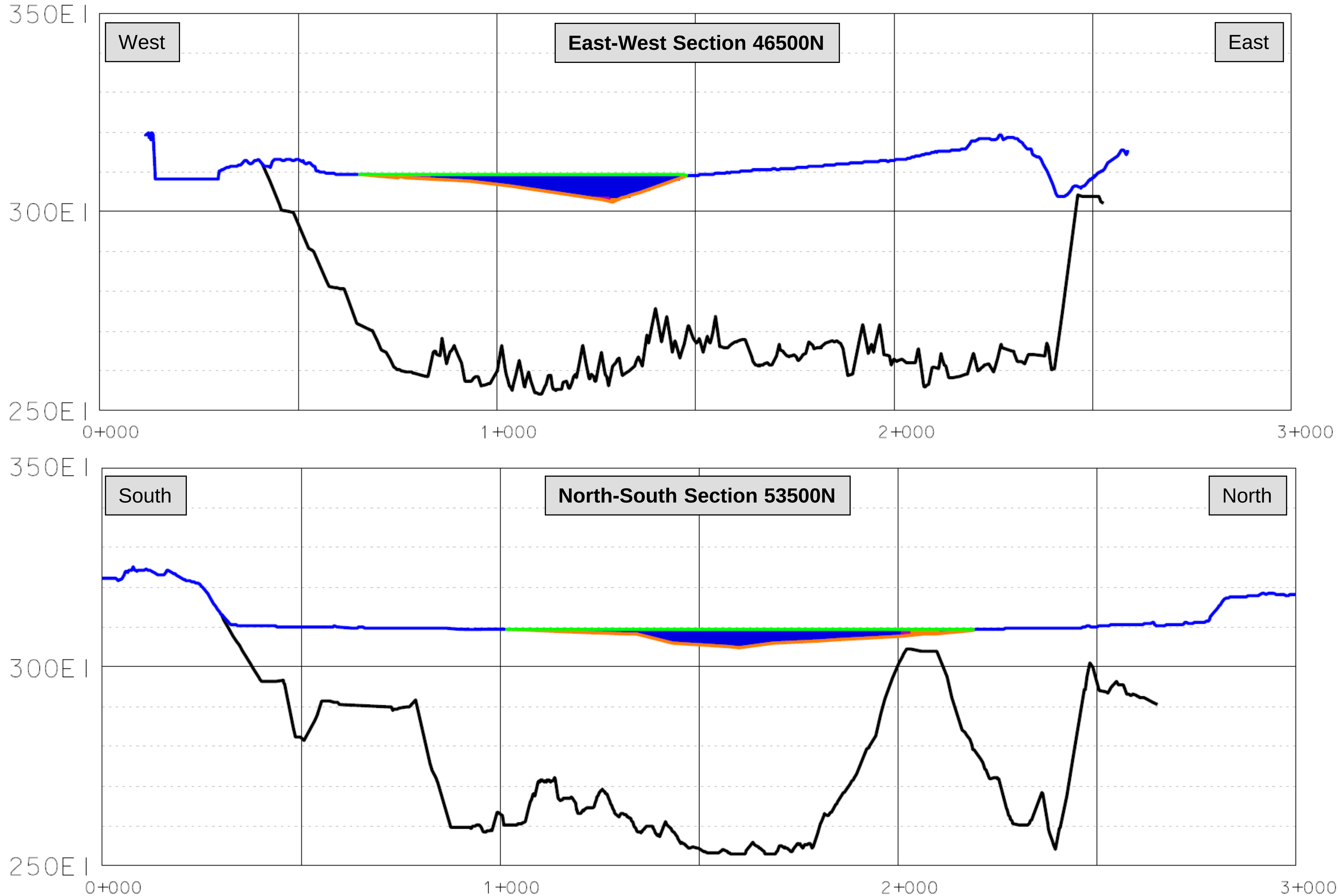
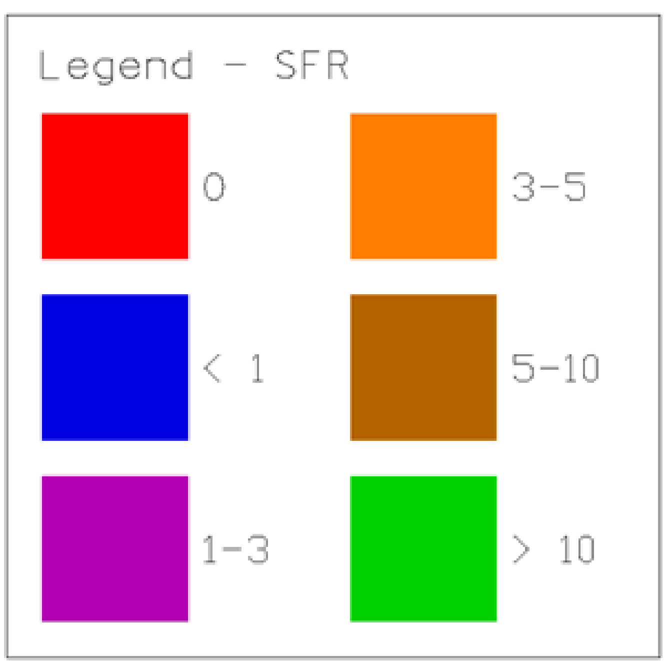
PROJECT:
2018 Tailings Report

TITLE:
EIP Fluid Tailings Cross Sections with Zone Interfaces

SCALE: 10x vertical exaggeration | REV 0 | **FIGURE 4-8**







Syncrude	PROJECT: 2018 Tailings Report	
DESIGN	TITLE: **EIP Fluid Tailings Cross Sections by SFR**	
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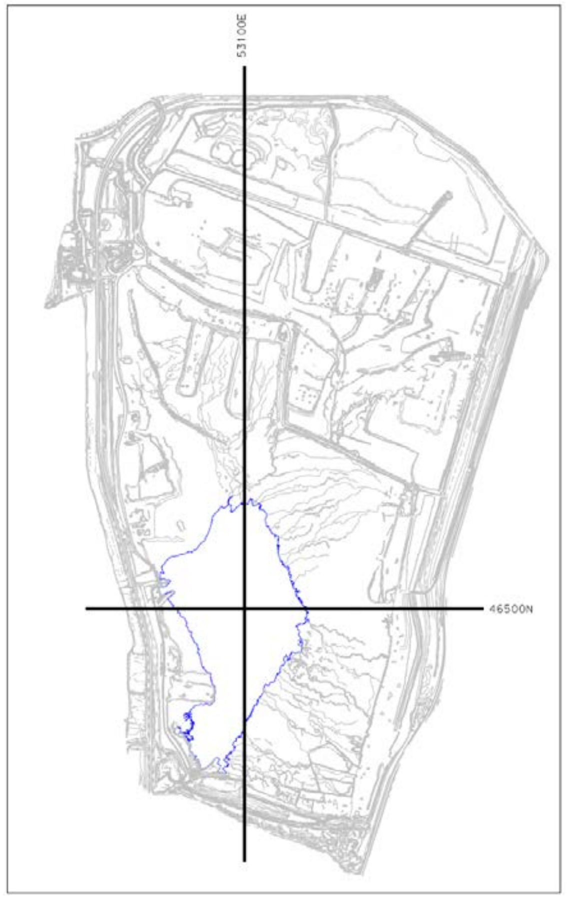
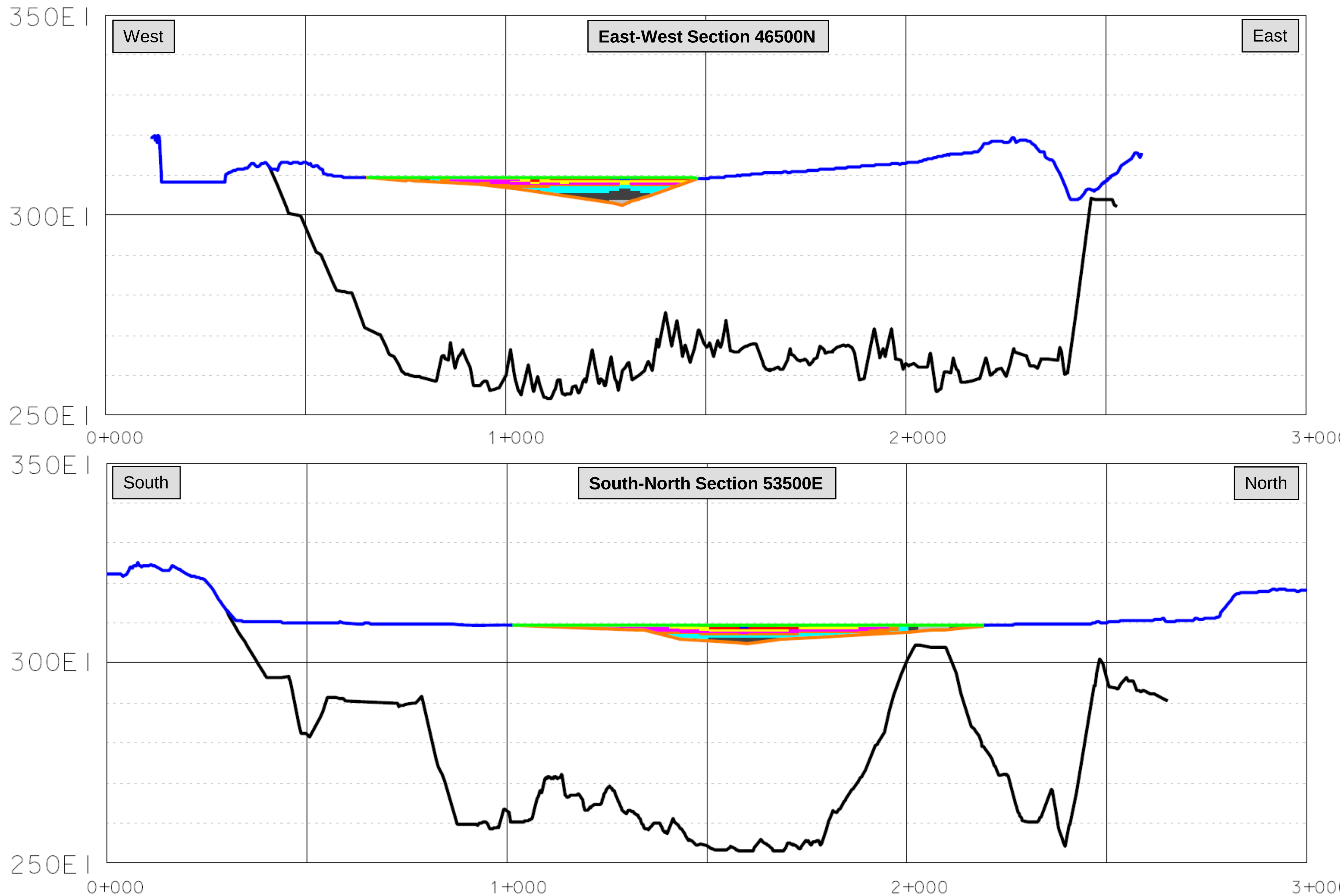
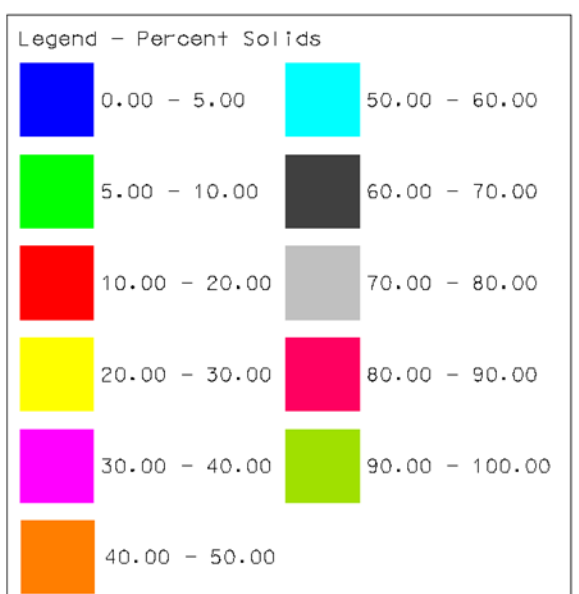
REVIEW	SCALE: 10x vertical exaggeration	REV 0

FIGURE 4-9







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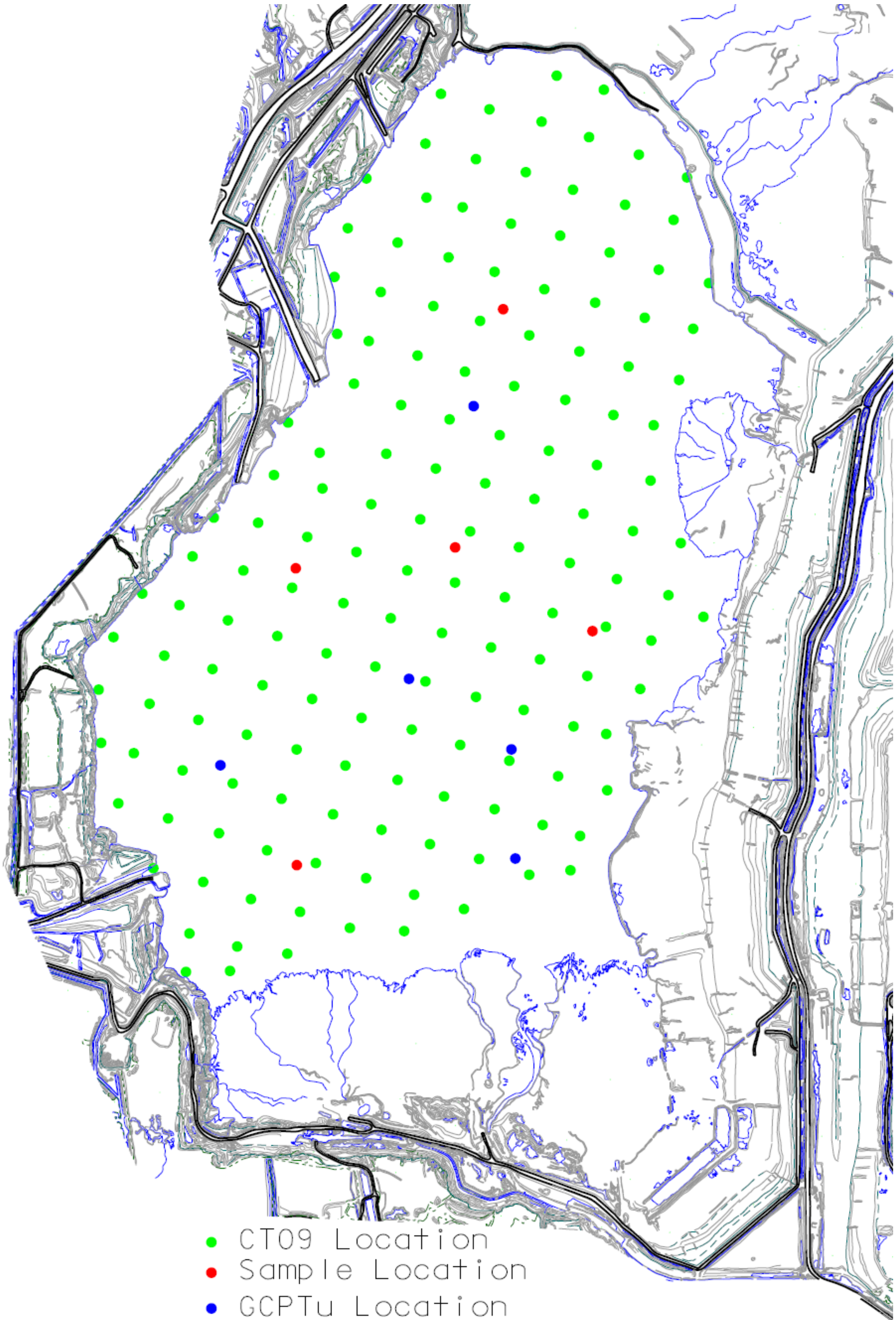
PROJECT: 2018 Tailings Report

TITLE: **EIP Fluid Tailings Cross Sections by % Solids**

SCALE: AS SHOWN | REV 0 | **FIGURE 4-10**

4.2.4 SWIP



Syncrude	PROJECT: 2018 Tailings Report		
	TITLE: **SWIP Sampling and Measurement Locations**		
DESIGN			
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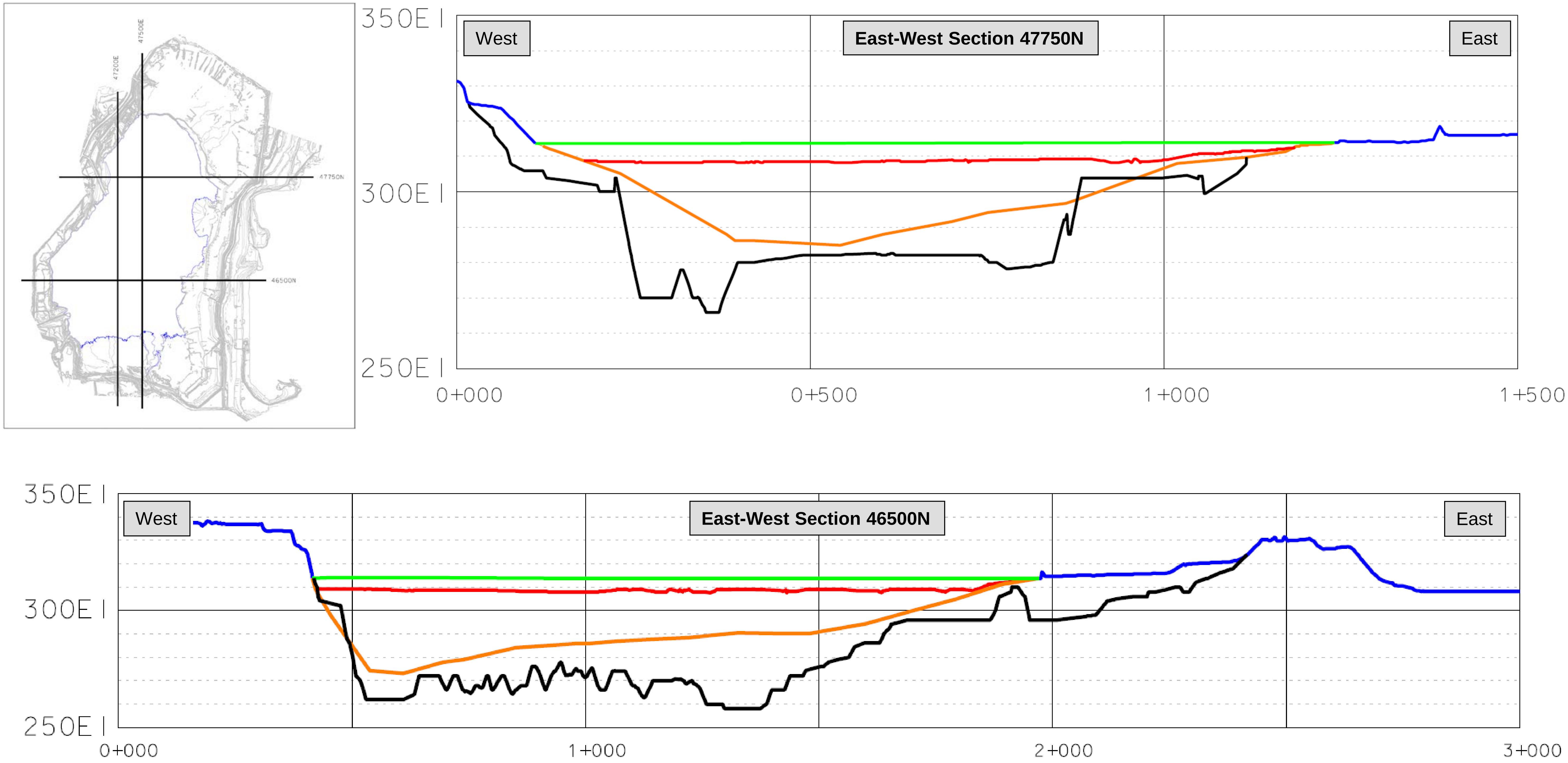
CHECK	SCALE: N/A	REV 0	**Figure 4-11**
REVIEW			



Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (May 2018)
- Pre-Tailings Deposition Surface

Syncrude

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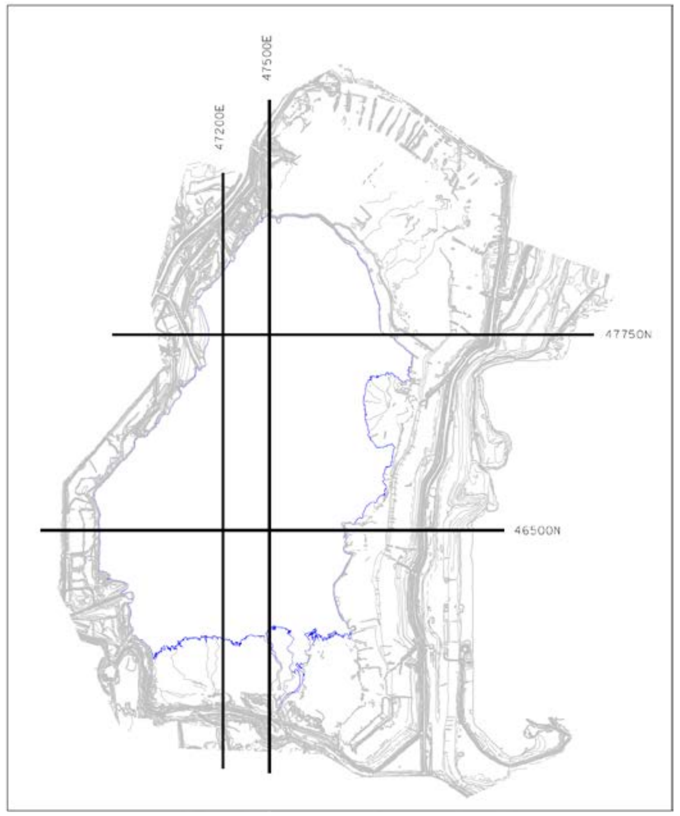
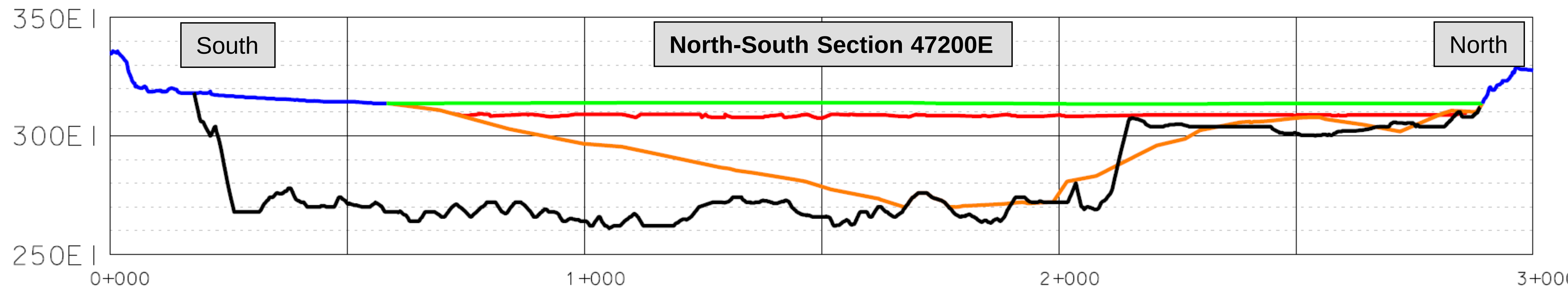
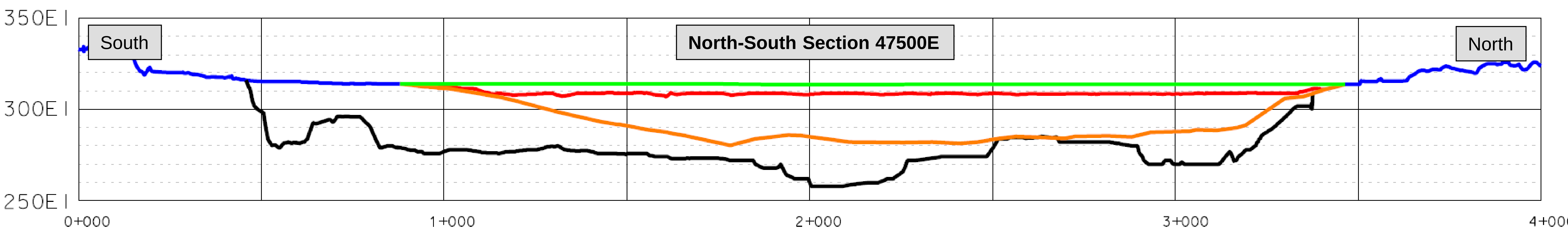
PROJECT: 2018 Tailings Report

TITLE: **SWIP E-W Fluid Tailings Cross Sections with Zone Interfaces**

SCALE: 5x vertical exaggeration | REV 0 | **FIGURE 4-12**







Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (May 2018)
- Pre-Tailings Deposition Surface

Syncrude

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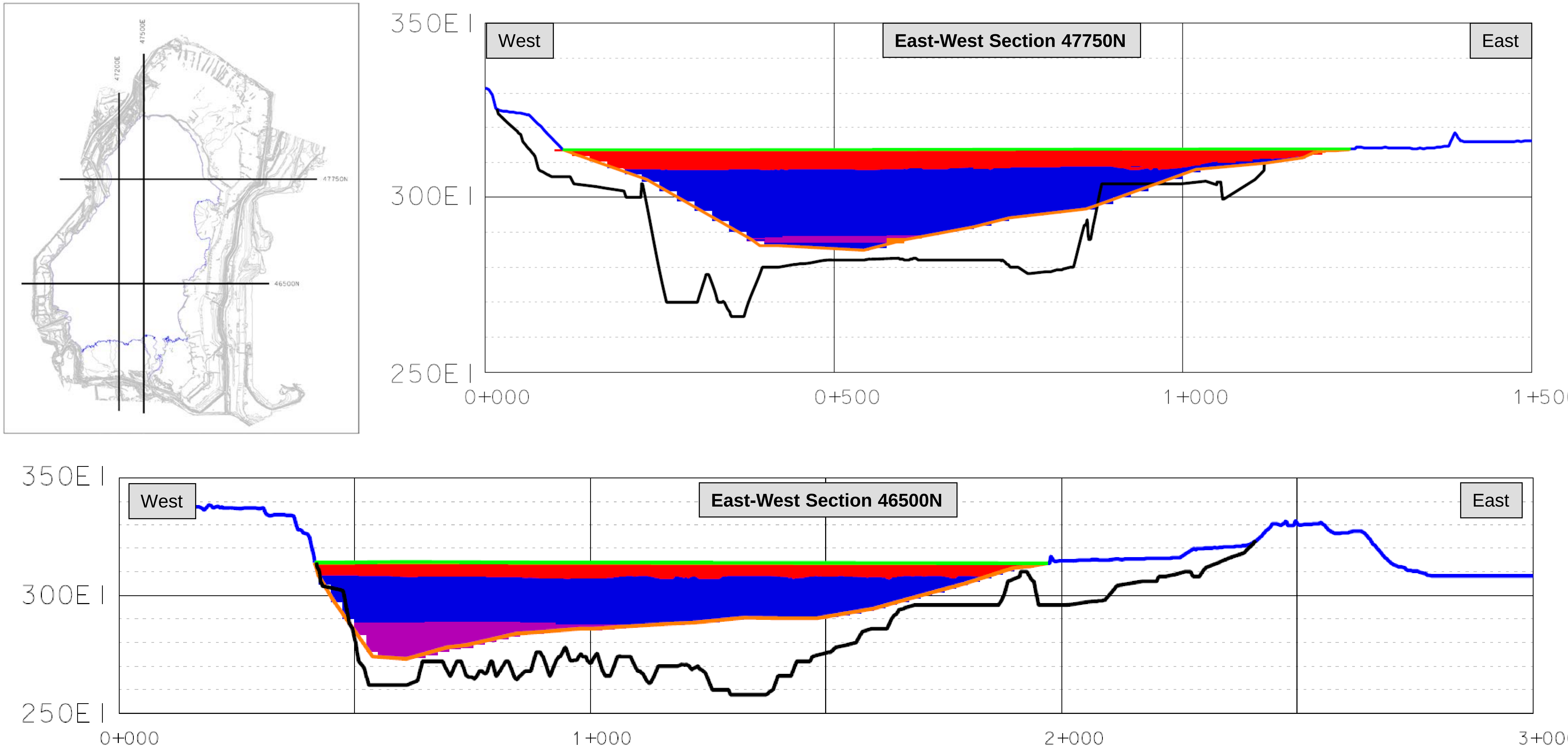
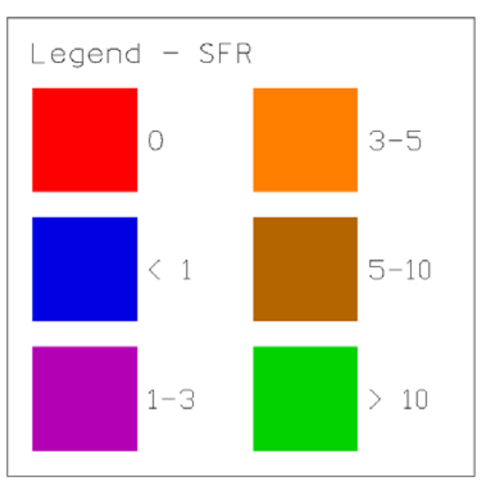
PROJECT: 2018 Tailings Report

TITLE: **SWIP N-S Fluid Tailings Cross Sections with Zone Interfaces**

SCALE: 5x vertical exaggeration | REV 0 | **FIGURE 4-13**





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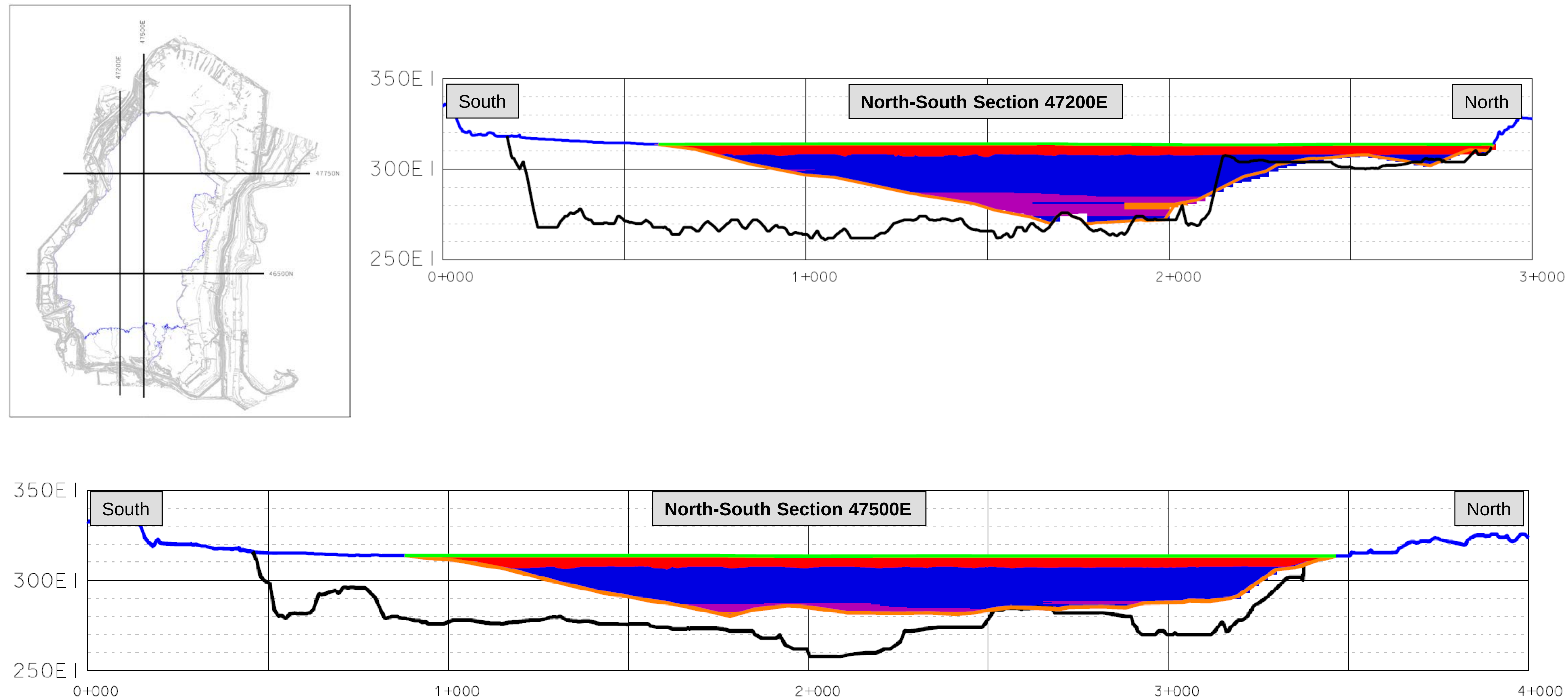
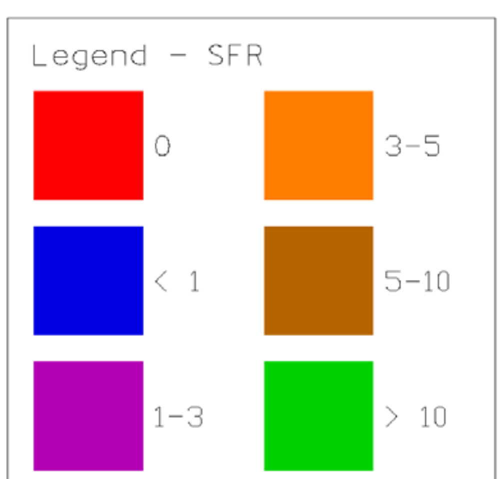
PROJECT: 2018 Tailings Report

TITLE: **SWIP E-W Fluid Tailings Cross Sections by SFR**

SCALE: 5x vertical exaggeration | REV 0 | **FIGURE 4-14**





Syncrude

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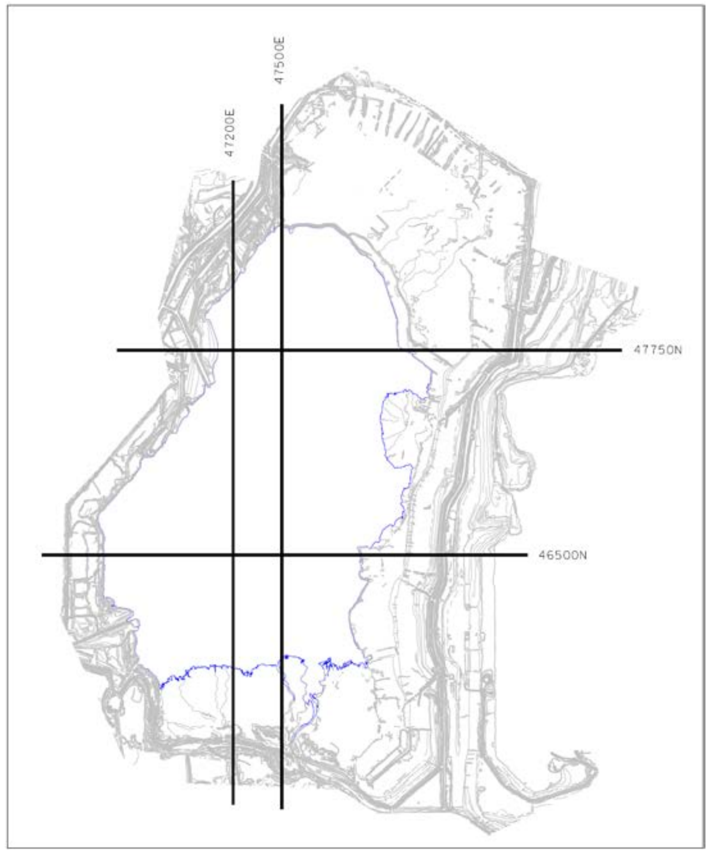
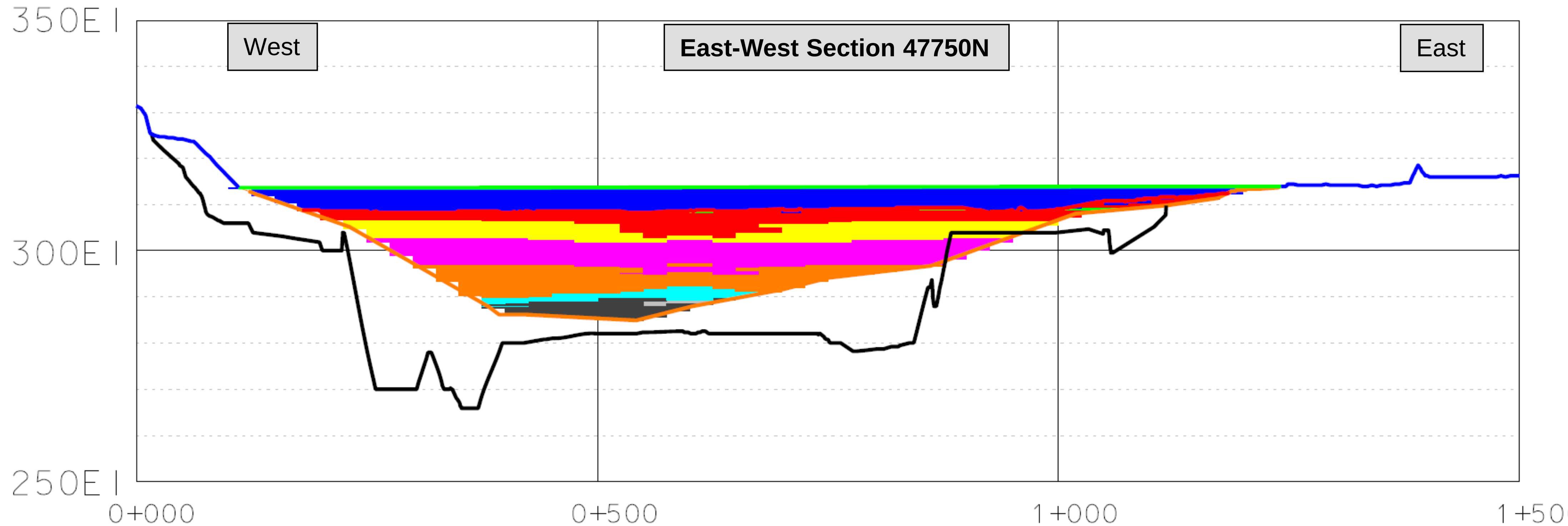
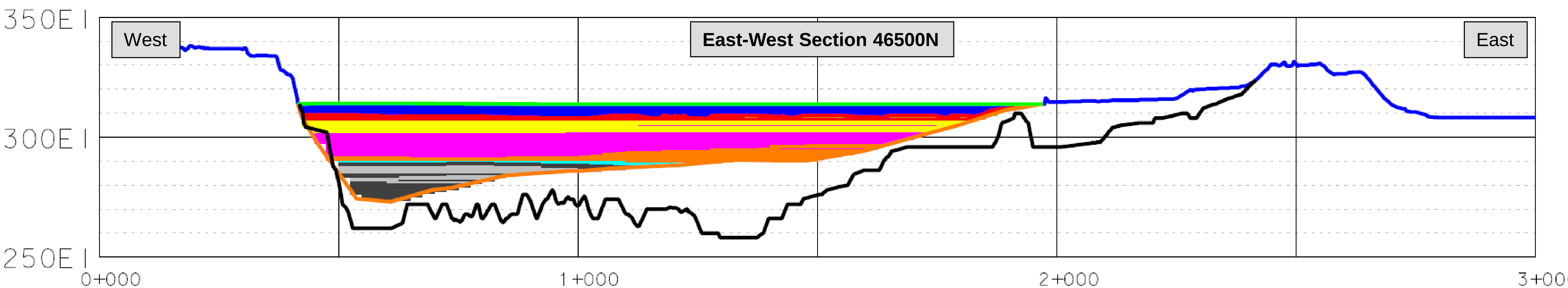
PROJECT: 2018 Tailings Report

TITLE: **SWIP N-S Fluid Tailings Cross Sections by SFR**

SCALE: 5x vertical exaggeration | REV 0 | **FIGURE 4-15**







Legend - Percent Solids

0.00 - 5.00	50.00 - 60.00
5.00 - 10.00	60.00 - 70.00
10.00 - 20.00	70.00 - 80.00
20.00 - 30.00	80.00 - 90.00
30.00 - 40.00	90.00 - 100.00
40.00 - 50.00	

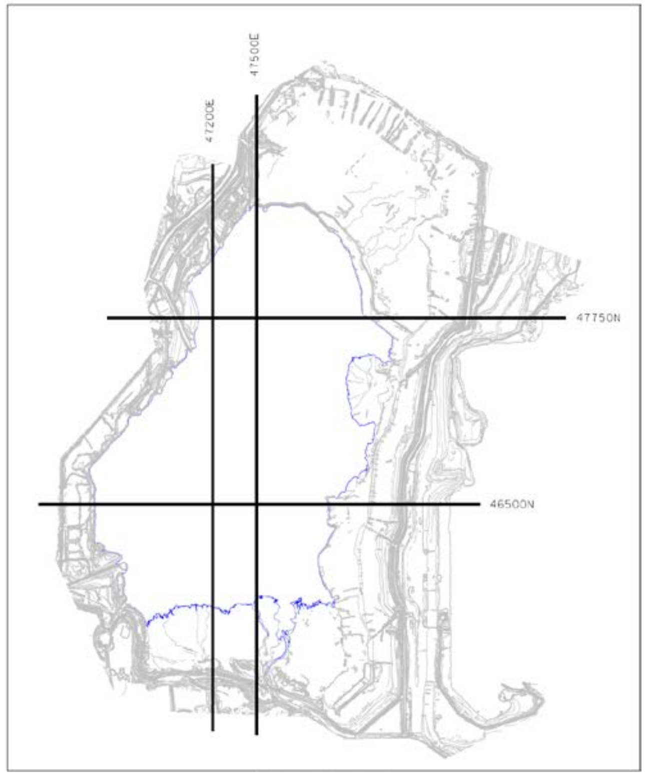
Syncrude

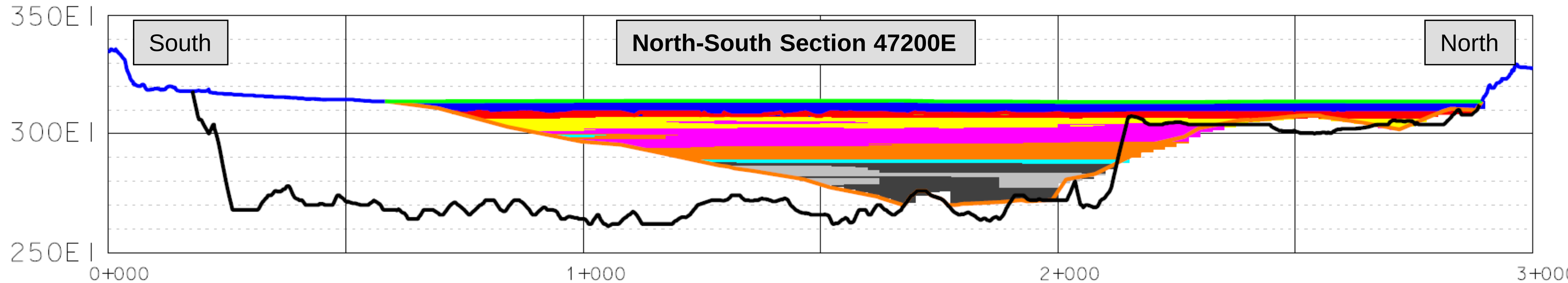
DESIGN		
CADD		
CHECK		
REVIEW		

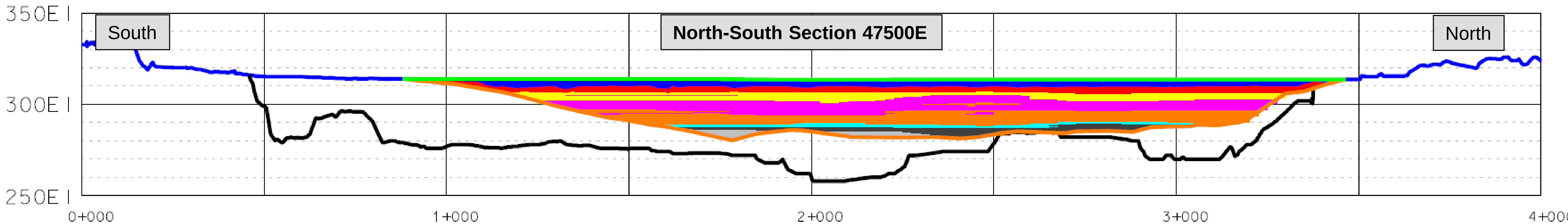
PROJECT:
2018 Tailings Report

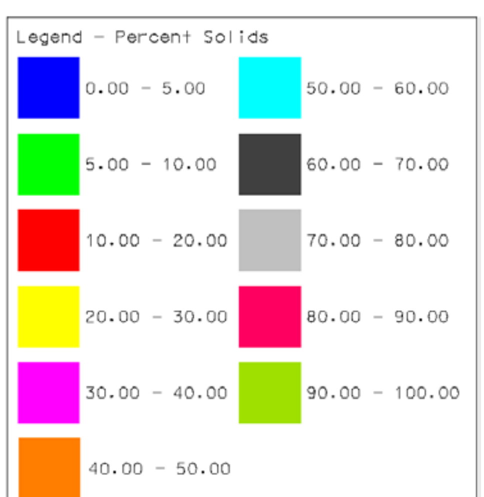
TITLE:
SWIP E-W Fluid Tailings Cross Sections by %Solids

SCALE: 5x vertical exaggeration | REV 0 | **FIGURE 4-16**









Syncrude

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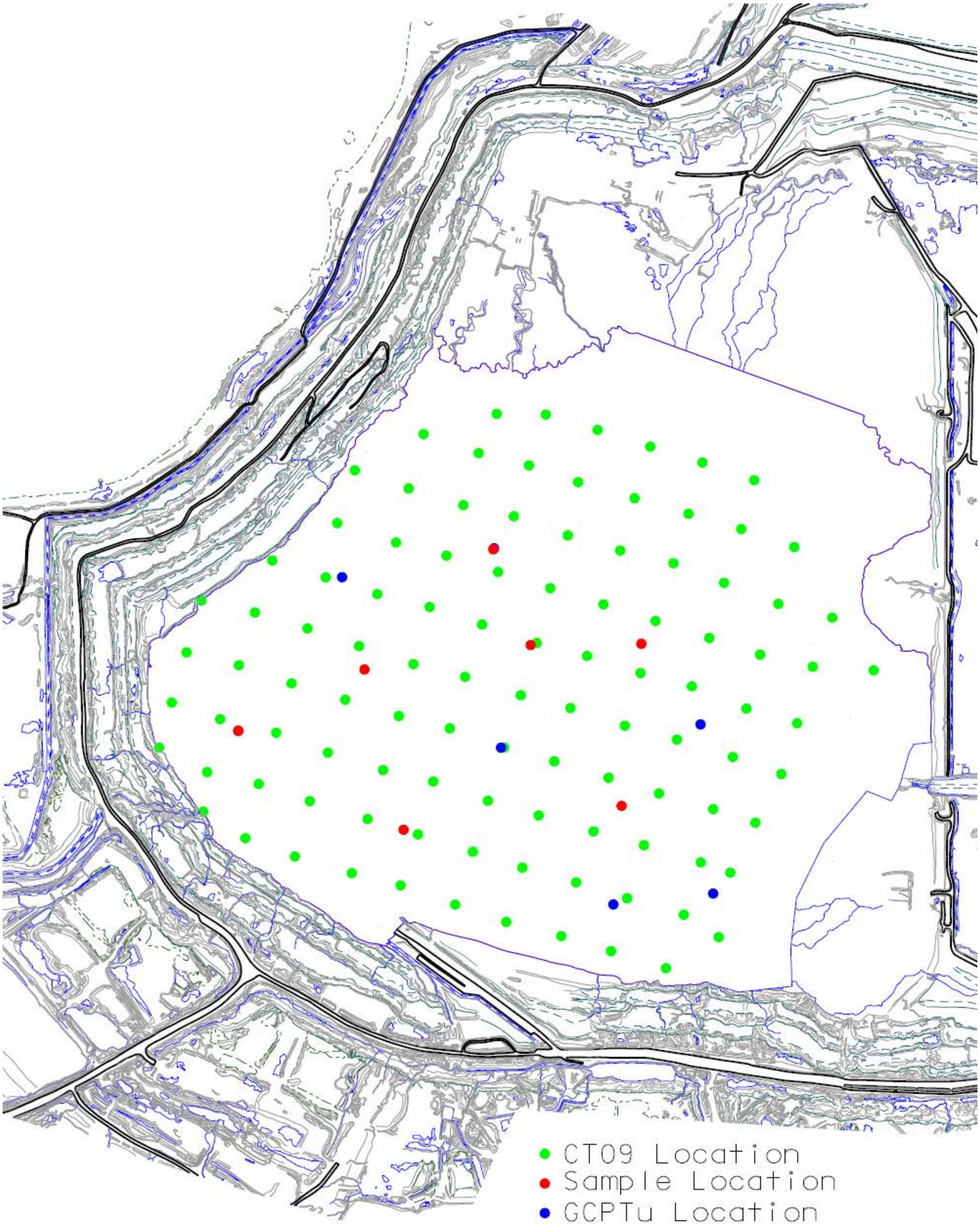
PROJECT: 2018 Tailings Report

TITLE: **SWIP N-S Fluid Tailings Cross Sections by % Solids**

SCALE: 5x vertical exaggeration	REV 0	**FIGURE 4-17**

4.2.5 NMSPW



Syncrude

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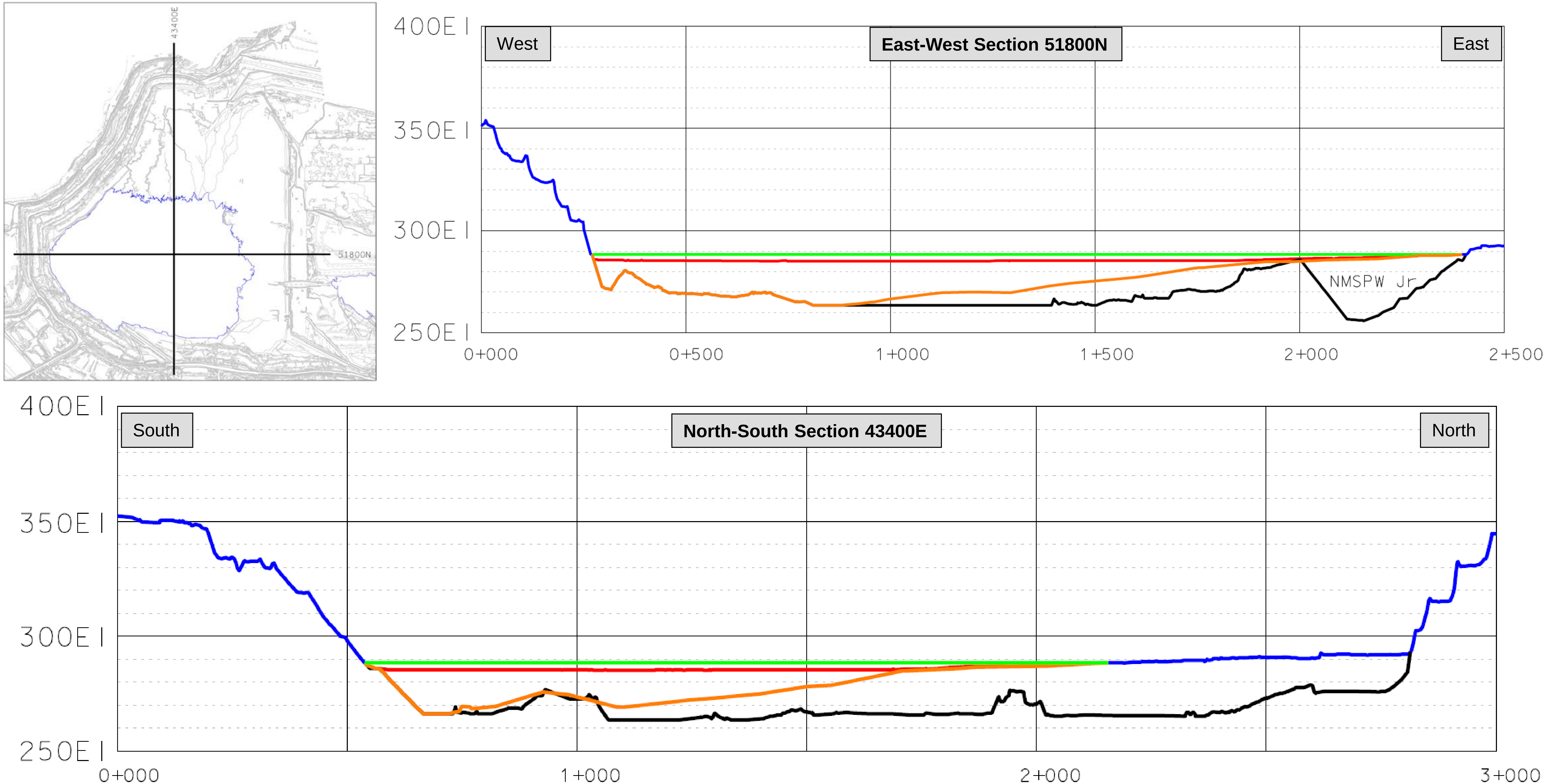
PROJECT: 2018 Tailings Report

TITLE: **NMSPW Sampling and Measurement Locations**

SCALE: N/A | REV 0 | **Figure 4-18**



Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (May 2017)
- Pre-Tailings Deposition Surface

Syncrude

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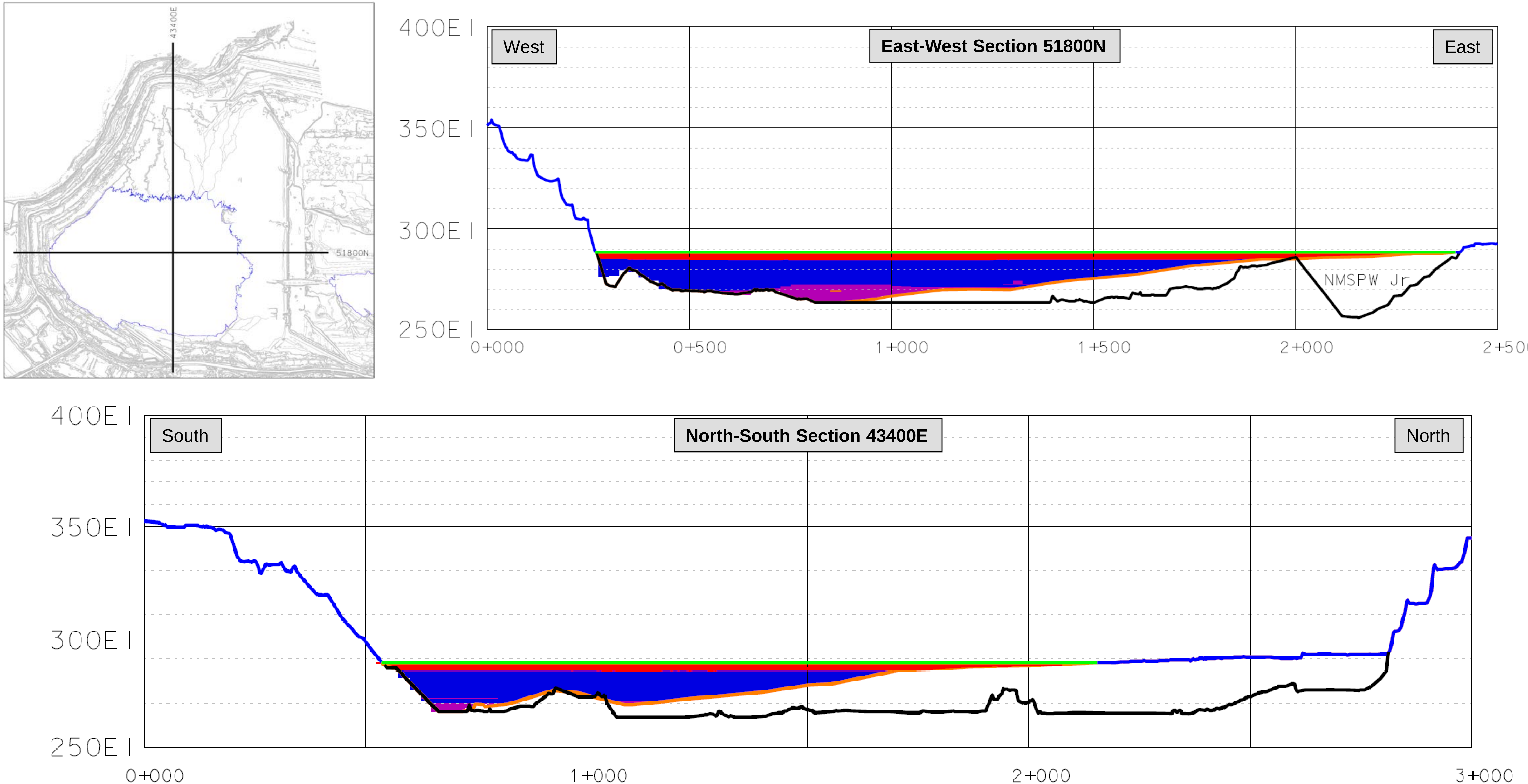
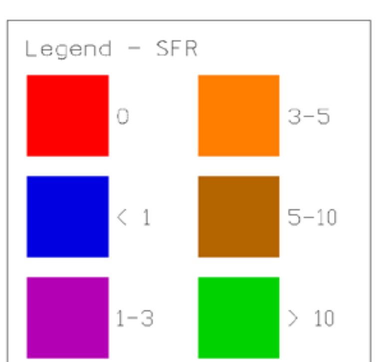
PROJECT: 2018 Tailings Report

TITLE: **NMSPW Fluid Tailings Cross Sections with Zone Interfaces**

SCALE: 5x vertical exaggeration	REV 0	**Figure 4-19**





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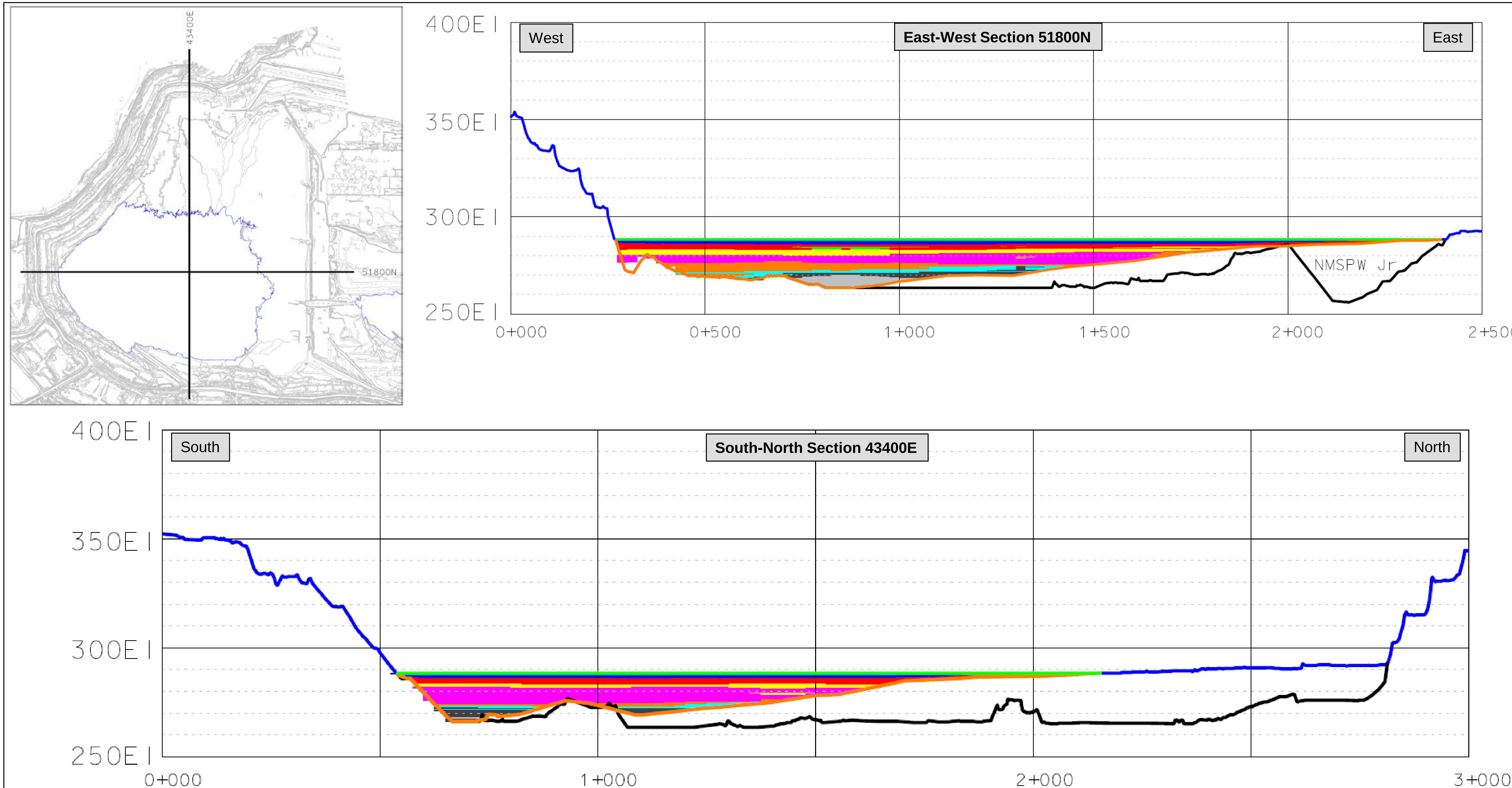
PROJECT:

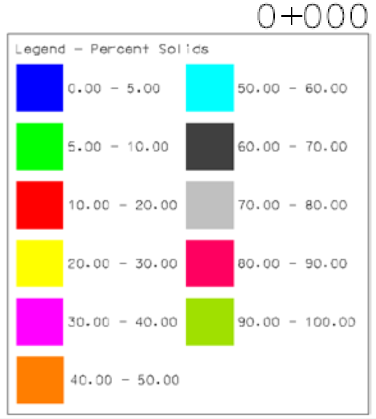
2018 Tailings Report

TITLE:

NMSPW Fluid Tailings Cross Sections by SFR

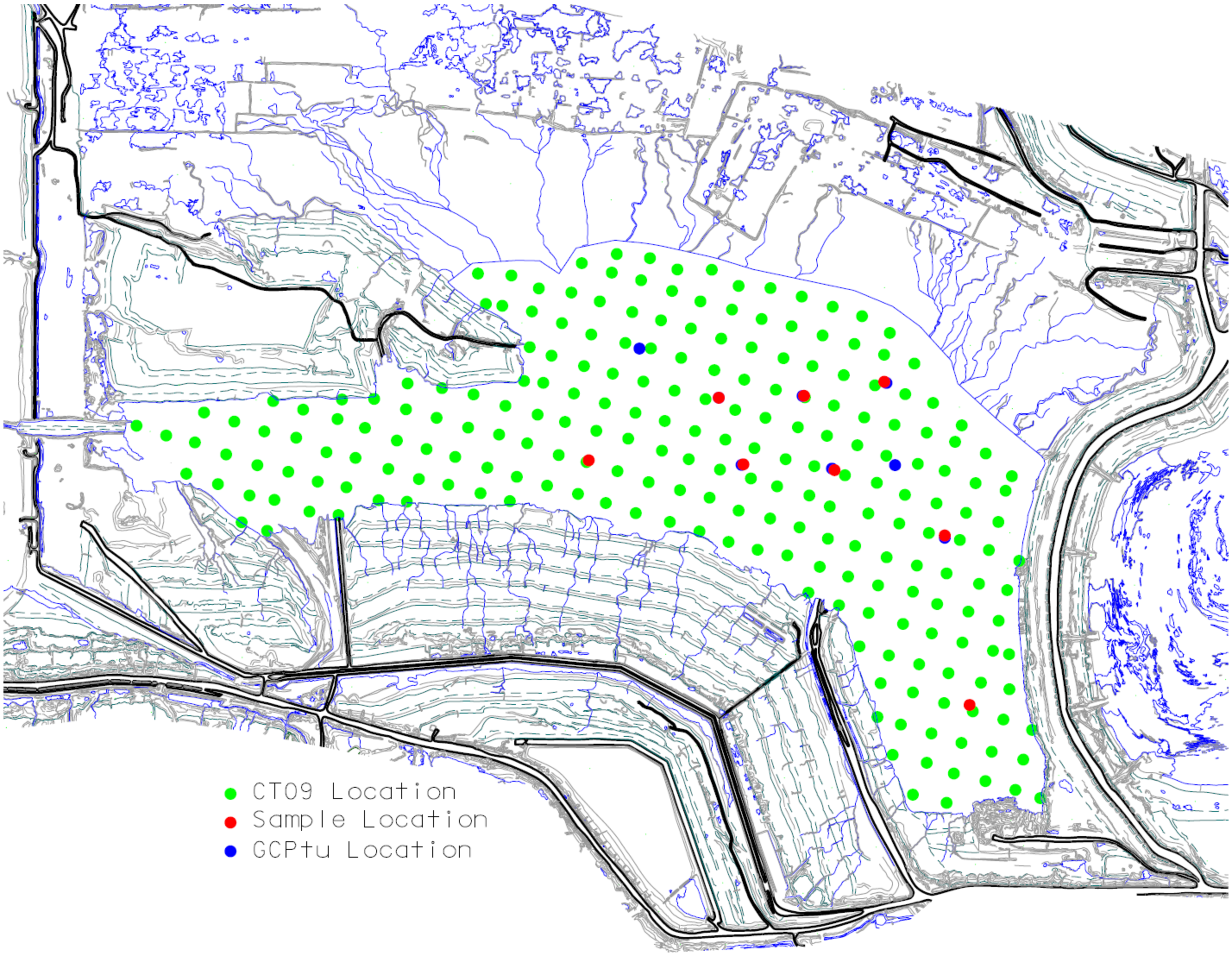
SCALE: 5x vertical exaggeration | REV 0 | **Figure 4-20**



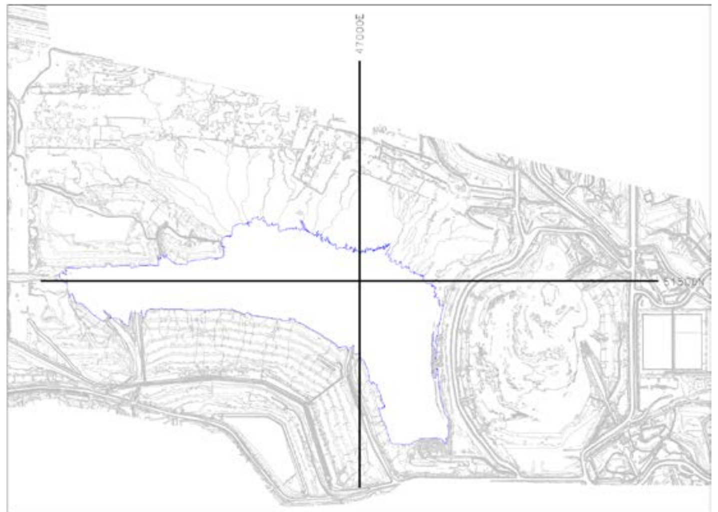


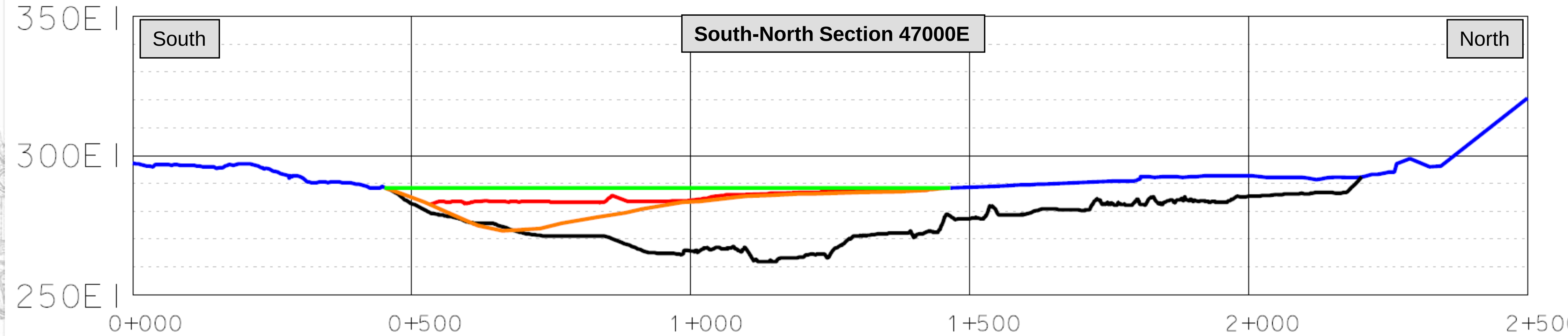
Syncrude	PROJECT: 2018 Tailings Report		
DESIGN	TITLE: **NMSPW Fluid Tailings Cross Sections by % Solids**		
CADD			
CHECK	SCALE: 5x vertical exaggeration	REV 0	**Figure 4-21**
REVIEW			

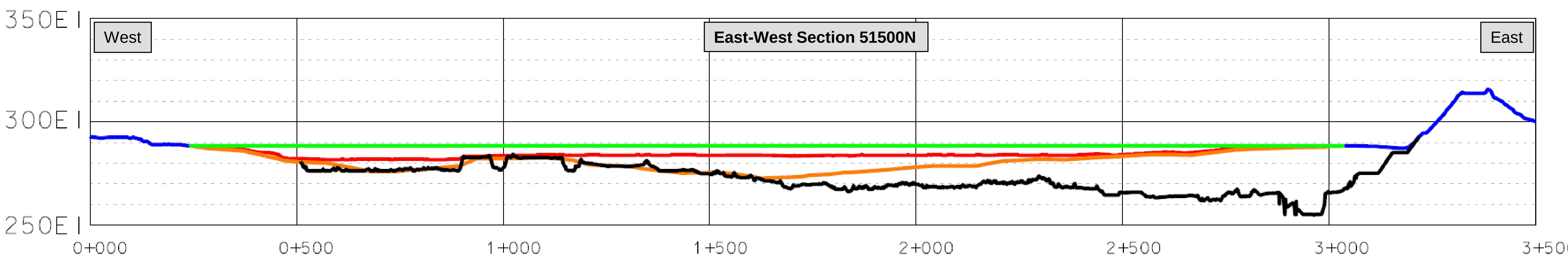
4.2.6 NMSPE



Syncrude	PROJECT: 2018 Tailings Report	
	TITLE: **NMSPE Sampling and Measurement Locations**	
DESIGN		
CADD		
CHECK	SCALE: N/A	REV 0
REVIEW		**Figure 4-22**



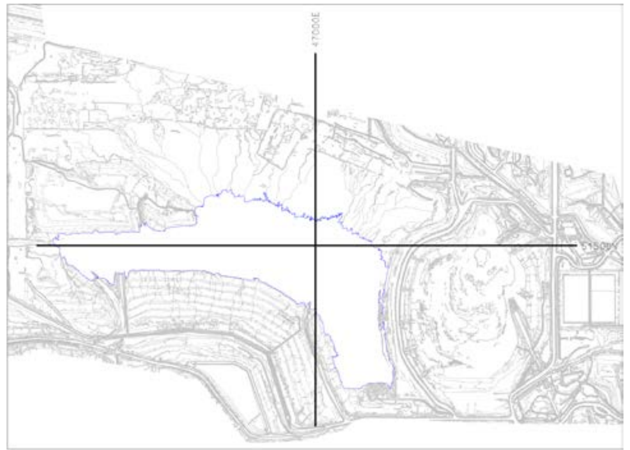


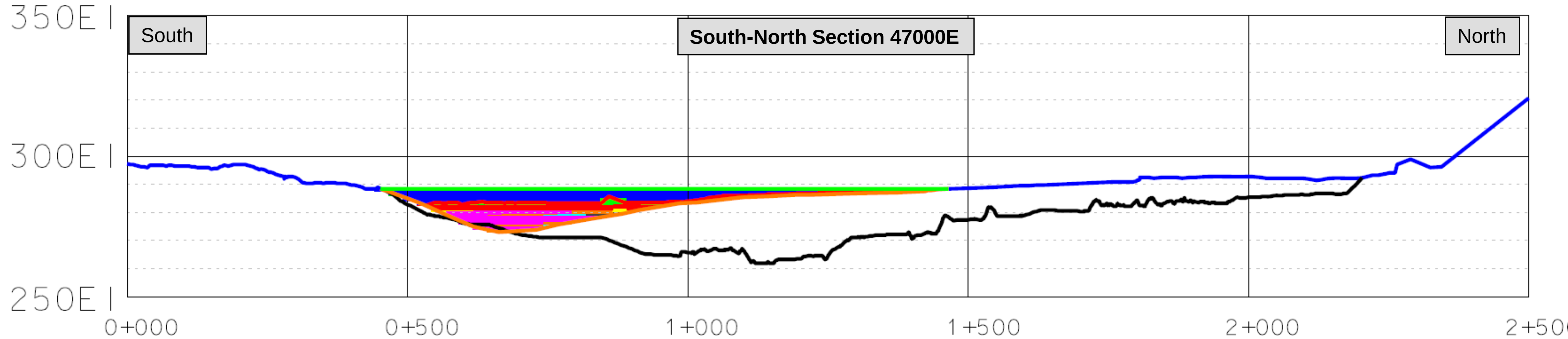


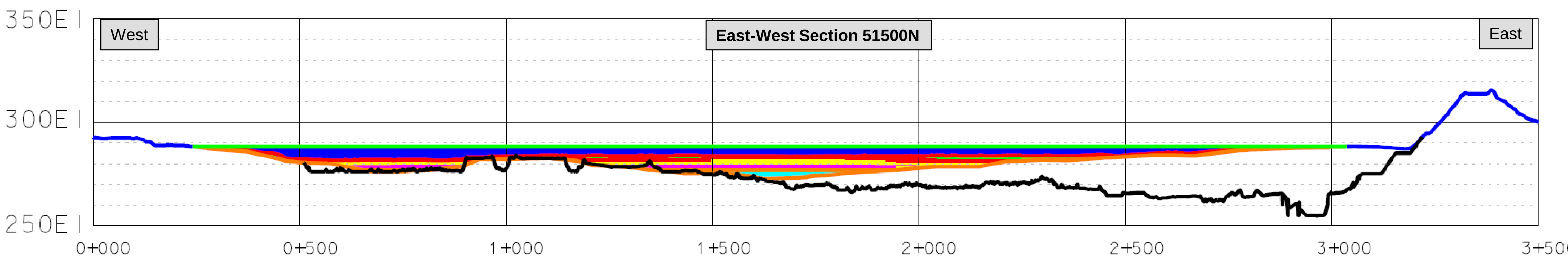
Legend

- Dyke/Beach Surface
- Water Level
- Fluid Fine Tailings Top
- Hardbottom Surface (August 2018)
- Pre-Tailings Deposition Surface

Syncrude			PROJECT: 2018 Tailings Report		
DESIGN			TITLE: **NMSPE Fluid Tailings Cross Sections with Zone Interfaces**		
CADD					
CHECK			SCALE: 5x Vertical Exaggeration	REV 0	**FIGURE 4-23**
REVIEW					







Legend – Percent Solids

- 0.00 – 5.00
- 5.00 – 10.00
- 10.00 – 20.00
- 20.00 – 30.00
- 30.00 – 40.00
- 40.00 – 50.00
- 50.00 – 60.00
- 60.00 – 70.00
- 70.00 – 80.00
- 80.00 – 90.00
- 90.00 – 100.00

Syncrude

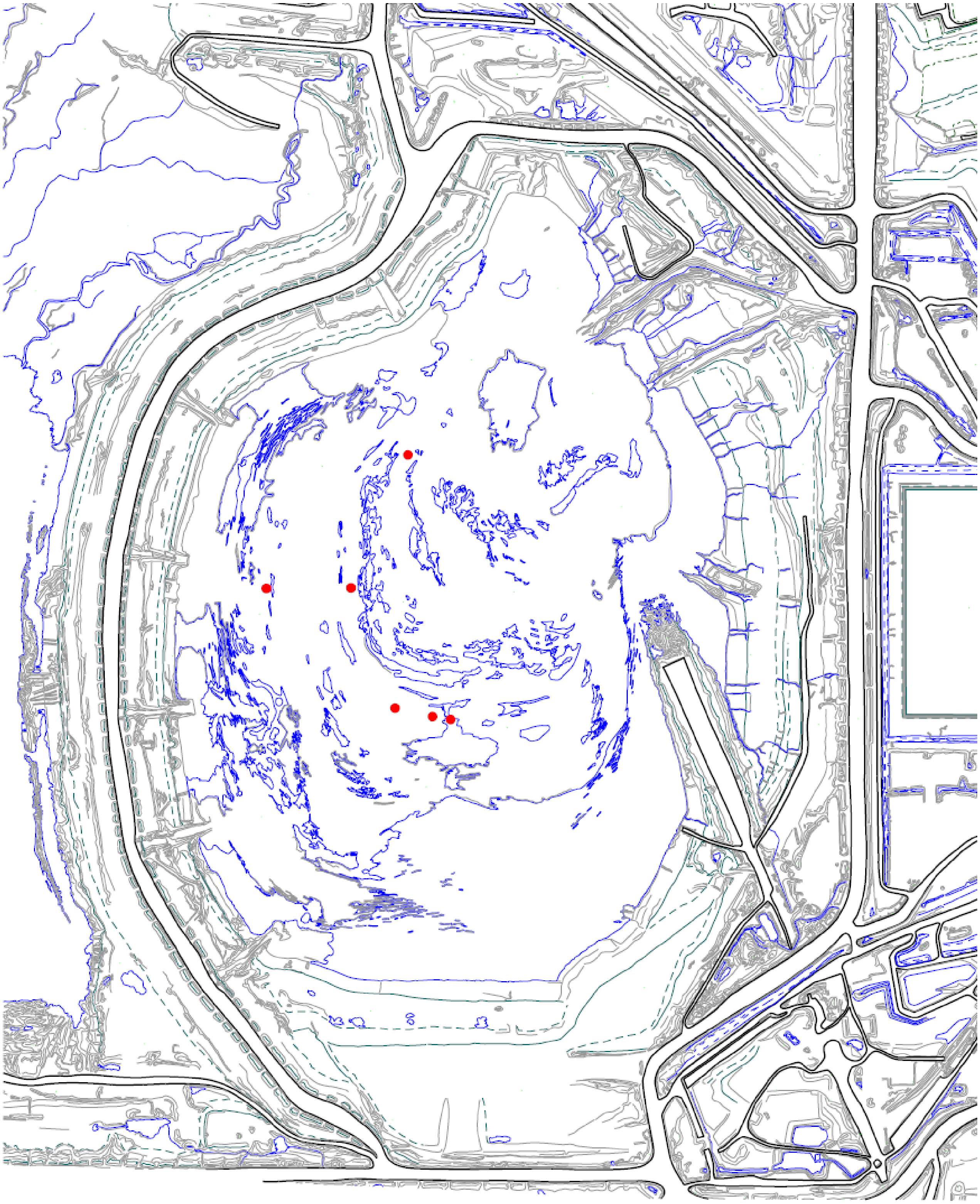
DESIGN		
CADD		
CHECK		
REVIEW		

PROJECT: 2018 Tailings Report

TITLE: **NMSPE Fluid Tailings Cross Sections by % Solids**

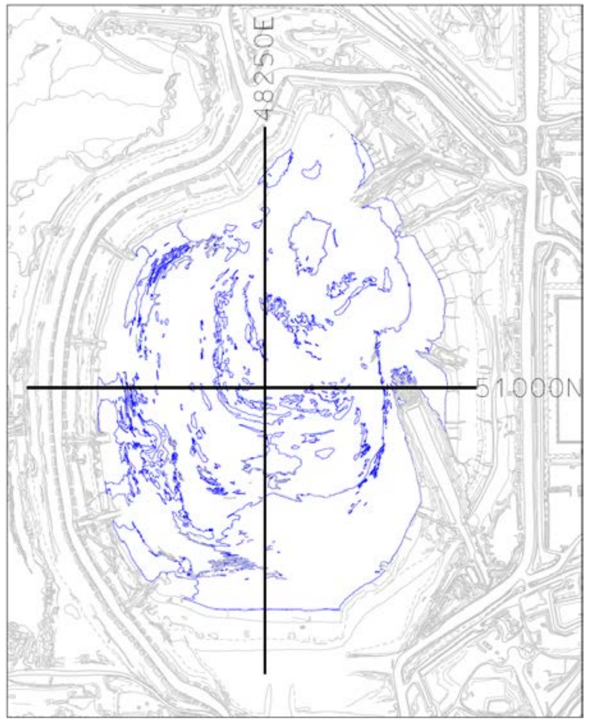
SCALE: 5x vertical exaggeration	REV 0	**FIGURE 4-24**

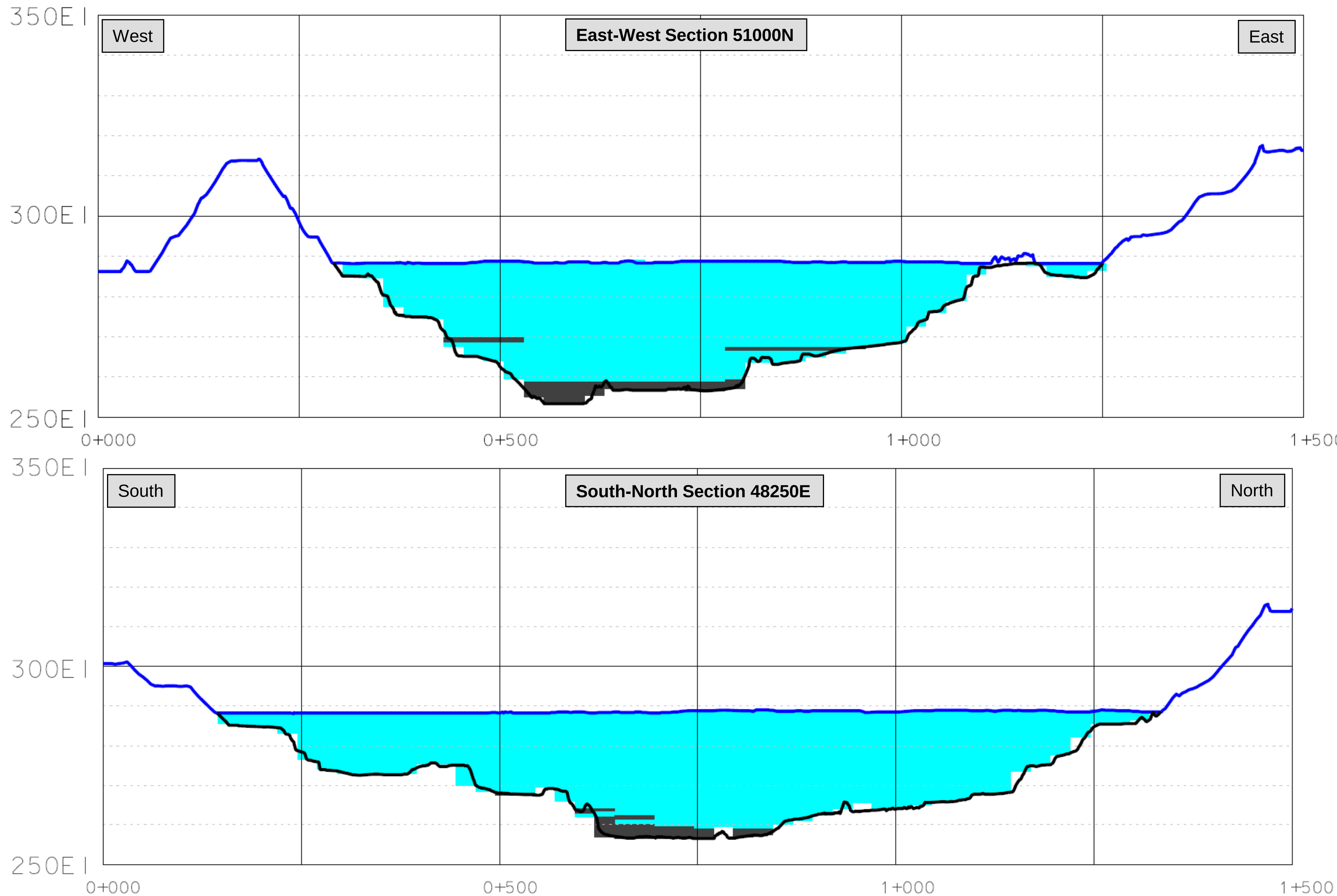
4.2.7 NMSPE Deep Cake Deposit

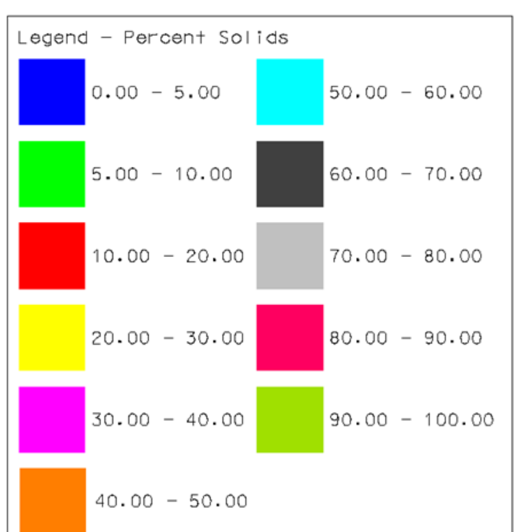


• Sample/GCPTu Location

Syncrude			PROJECT: 2018 Tailings Report
DESIGN			TITLE: **Deep Cake Sampling and Measurement Locations**
CADD			
CHECK			SCALE: N/A — REV 0 — **Figure 4-25**
REVIEW			







DESIGN		
CADD		
CHECK		
REVIEW		

PROJECT:

2018 Tailings Report

TITLE:

Deep Cake Cross Sections by % Solids

SCALE: 5x Vertical Exaggeration | REV 0 | **FIGURE 4-26**

5 Tailings Water Quality

An integral part of Syncrude's water management is assessing on-site water quality via the collection of recycle water samples from in-pit and out-of-pit tailings structures. In addition, the pore water present in the fluid fine tails (FFT) is also sampled and characterized. Samples are submitted to Syncrude's Research Laboratory and external accredited laboratories for analysis of organic and inorganic constituents. Because the tailings structures are hydraulically integrated (i.e. the outflow of one pond is an inflow to another, etc.) differences in the water quality between the ponds is, in general, not significant. In 2018, samples were strategically collected from the following tailings deposits:

- MLSB
- SWSS
- SWIP
- BML
- NMSPE

Results from the 2018 annual tailings water sampling program are provided in this section.

5.1 MLSB

Table 5-1 MLSB - General Chemistry of Recycle Water and FFT

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) [2]						
Sample Depth (m)		**0.5**	**3**	**8**	**13**	**18**	**23**	**28**	**33**
Sample Elevation (AMSL) (m)		**348.5**	**346**	**341**	**336**	**331**	**326**	**321**	**316**
General									
pH (units)		8.00	8.47	8.66	8.61	8.44	8.67	8.8	8.55
Conductivity (uS/cm)	***2***	2900	4100	4300	4300	4200	4400	4400	4400
Temperature (°C)		17.1	12.0	15.0	17.3	18.4	18.8	18.8	18.9
Dissolved Solids (mg/L)**	***10***	1600	2100	1400	1800	1500	2600	2500	1700
Solids Content (g/100g)		0.03	36.3	43.7	52.9	59.5	64.4	69.2	71.2
Alkalinity (Total as $CaCO_3$) ($mg.L^{-1}$)**	***0.5***	517	1259	1106	1187	1119	1145	1148	1077
Chemical Oxygen Demand ($mg.L^{-1}$)**	***5***	280	200	220	210	200	240	270	280
Biological Oxygen demand ($mg.L^{-1}$)	***2***	21	-	-	-	-	-	-	-
Dissolved Oxygen ($mg.L^{-1}$)		-	-	-	-	-	-	-	-
Redox Potential (mV)		180	-	-	-	-	-	-	-
Phenols ($ug.L^{-1}$)**	***2***	44	18	18	14	12	14	14	16
Tannin & Lignins (mg.L-1)**	***0.4***	4.6	1.6	1.5	1.3	1.6	1.7	2.0	1.8
Cyanide ($ug.L^{-1}$)**	***2***	26	3.1	3.2	2.5	<2	2.7	2.8	14
MBAS ($mg.L^{-1}$)**	***0.10***	-	0.43	0.44	0.36	0.33	0.39	0.47	0.42
Sulphides ($ug.L^{-1}$)	***2***	32	31	16	17	10	16	10	16
Hydrogen Sulphide ($ug.L^{-1}$)	***2***	34	33	17	18	11	17	11	17
Methane (ml/L)	***0.8***	-	-	-	-	-	-	-	-
Methyl Hg (ng/L)	***0.02***	0.06	<0.02	0.028	<0.02	<0.02	0.042	<0.02	<0.02
Mercury (Hg) (ug/L)	***0.02***	0.003	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic (As) (ug/L)	***0.20***	11.1	3.3	29.8	28.8	35.6	33.8	31.2	31.8
Selenium (Se) (ug/L)	***0.20***	30.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Pet. Hydrocarbon ($mg.L^{-1}$)	***2***	9.8	37700	9590	*5500*	18130	14480	10870	10040
Bitumen Content (% by wt.)	***0.01***	<0.01	9.4	4.4	1.9	3.0	2.3	1.5	1.5
Naphtha Content (% by wt.)	***0.01***	<0.01	0.45	0.06	0.03	0.05	0.04	0.03	0.02
Total PAH's (mg/Kg)	***0.01***	<0.01	413	169	141	232	227	157	144
Alkylated PAH's as % of Total PAH's		69	96	94	96	98	97	97	98
Dis. Inorganic Carbon (($mgC.L^{-1}$)**	***1***	120	320	270	290	270	280	280	290
Dis. Organic Carbon ($mgC.L^{-1}$)**	***2.5***	40	56	44	42	46	48	54	58
Naphthenic Acids ($mg.L^{-1}$)	***5***	42	41	71	54	66	64	71	73
Citrate (mg.L-1)	***1***	<1	<1	<1	<1	<1	<1	<1	<1
Na/Cl Ratio (meq/meq)		2.43	2.09	1.99	2.03	2.05	1.93	1.98	2.01
Major Ion Ratio (∑Cat/∑An meq/meq)		0.99	1.02	1.03	0.99	1.01	0.96	0.97	1.02
Hardness (as mg/L $CaCO_3$)**		141	302	91	102	76	59	52	49
Acute Toxicity									
Rainbow Trout LC_{50} (% by vol)		27	-	-	-	-	-	-	-
Rainbow Trout (% survival at 96 hrs.)		0	-	-	-	-	-	-	-
Daphnia Magna LC_{50} (% by vol)		>100	-	-	-	-	-	-	-
Daphnia Magna EC_{50} (% immobility)		>100	-	-	-	-	-	-	-
Microtox IC_{50} (% by vol)		55	-	-	-	-	-	-	-
Microtox IC_{20} (% by vol)		16	-	-	-	-	-	-	-
Nutrients									
o-Phosphate ($ugP.L^{-1}$)	***3***	15	18	95	33	60	55	130	110
Total Phosphorous ($ugP.L^{-1}$)	***3***	130	16	11	67	120	75	17	25
Ammonia ($mgN.L^{-1}$)	***0.15***	22	41	12	9	10	9.4	8.1	8.1
Nitrite ($ugN.L^{-1}$)	***10***	<50	<10	32	<10	<10	<10	<10	<10
Nitrate ($ugN.L^{-1}$)	***10***	<50	<10	260	21	21	<10	45	12
Nitrate + Nitrite ($ugN.L^{-1}$)	***10***	<70	<10	290	21	21	<10	45	<10
Total Nitrogen ($mgN.L^{-1}$)	***0.5***	25	36	14	8.9	16	10	9.4	7.9
Silicon ($mg.L^{-1}$)	***0.10***	3.7	6.5	3.9	4.2	3.6	3.9	4.0	3.0
Major Ions ($mg. L^{-1}$)									
Cations ($mg. L^{-1}$)									
Sodium (Na^+)	***2.5***	590	840	965	960	945	940	960	990
Potassium (K^+)	***0.3***	11	22	17	15	14	14	14	13
Magnesium (Mg^{+2})	***0.2***	14	40	11	13	9.8	8.1	7.1	6.8
Calcium (Ca^{+2})	***0.3***	33	54	18	19	14	10	9	8.3
Total Cations (meq/L)		***29.0***	***43.7***	***44.7***	***44.6***	***43.3***	***42.8***	***43.5***	***44.7***
Anions ($mg. L^{-1}$)									
Fluoride (F^-)	***0.05***	2.1	1.4	3.1	2.4	2.9	3.2	5	4.7
Chloride (Cl^-)	***5***	375	620	750	730	710	750	750	760
Bromide (Br^-)	***0.015***	0.34	0.32	0.42	0.36	0.36	0.46	0.46	0.46
Sulphate ($SO_4^=$)	***5***	410	1.5	15	24	19	31	31	47
Carbonate ($CO_3^=$)	***0.5***	5	15	44	41	20	43	59	29
Bicarbonate (HCO_3^-)	***0.5***	620	1505	1260	1365	1325	1310	1280	1255
Total Anions (meq/L)		***29.4***	***42.7***	***43.6***	***44.8***	***42.8***	***44.7***	***44.7***	***43.9***

Sample Date: May 14, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (centrifuged and filtered).
** Samples centrifuged at 30000g, then filtered (0.45u filter-passing). Naphthenic Acid, (FTIR), Bitumen and Solids (OWS), Naphtha analyses by Syncrude Research Lab.

Table 5-2 MLSB - Solids Fraction Profiles in FFT

	Fluid Fine Tailings (FFT)**						
Sample Depth (m)	**3**	**8**	**13**	**18**	**23**	**28**	**33**
Sample Elevation (AMSL) (m)	**346**	**341**	**336**	**331**	**326**	**321**	**316**
Solids Content** (g/100g)	36.3	43.7	52.9	59.5	64.4	69.2	71.2
Fines Content -44*um / (-44um+w)*	35.6	42.4	49.9	50.2	52.8	54.2	55.6
Fines Content -*22um / (-22um+w*)	33.2	38.9	44.8	45.2	46.8	48.9	49.4
Fines Content -*11um / (-11um+w)*	28.2	32.5	37.8	38.3	39.5	41.8	41.8
Fines Content -*5.5um / (-5.5um+w)*	23.1	26.4	33.0	31.8	33.1	35.3	34.8
Fines Content -2.8*um / (-2.8um+w)*	16.7	19.6	23.5	23.9	25.4	27.3	26.6
SFR** (>44um / <44um)	0.08	0.08	0.15	0.50	0.66	0.94	1.02
Bitumen (g/100g)	9.41	4.37	1.91	2.96	2.30	1.52	1.47
Naphtha (g/100g)	0.45	0.06	0.03	0.05	0.04	0.03	0.02
Calc. Density (g/ml)	1.29	1.37	1.49	1.59	1.66	1.75	1.79
Size Fraction	**Particle Size Distribution*** (% solids less than)**						
1440um	100	100	100	100	100	100	100
900um	100	100	100	100	100	100	100
720um	100	100	100	100	100	100	100
500um	100	100	100	100	100	100	100
360um	100	100	100	100	100	100	100
250um	100	100	100	100	100	99	99
180um	100	100	100	96.3	94.6	87.8	89.3
125um	97.5	98.9	97.3	86.7	82.5	71.6	73.3
88um	95.8	97.4	94.6	78.8	73.4	62.2	62.4
62um	94.2	95.7	92.3	72.7	66.7	56.4	55.5
44um	92.3	92.5	87.0	66.7	60.3	51.6	49.6
31um	87.5	86.0	80.0	59.9	53.0	46.0	43.4
22um	82.9	79.8	71.0	54.6	47.4	41.6	38.7
16um	75.5	71.2	65.0	48.4	41.6	36.8	33.9
11um	65.6	60.4	53.0	41.1	35.2	31.2	28.5
7.8um	58.3	52.7	49.0	36.1	30.9	27.5	24.8
5.5um	50.2	45.0	43.0	30.9	26.7	23.7	21.2
3.9um	41.5	37.3	35.0	25.7	22.4	19.8	17.6
2.8um	33.6	30.6	27.0	21.1	18.6	16.5	14.5
1.9um	25.4	23.6	19.0	16.4	14.6	12.8	11.4
1.4um	19.5	18.5	16.0	12.8	11.5	10.0	9.0
1.0um	13.7	13.2	11.5	9.1	8.2	7.1	6.6
0.7um	8.5	8.4	8.0	5.8	5.2	4.4	4.3
0.5um	4.8	4.8	4.5	3.3	3.0	2.5	2.5
0.35um	2.19	2.17	2.24	1.49	1.38	1.12	1.21
0.25um	0.78	0.76	0.77	0.53	0.50	0.39	0.47
0.18um	0.20	0.19	0.18	0.14	0.13	0.09	0.14
0.13um	0.02	0.02	0.02	0.02	0.02	0.01	0.02
0.10um	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean Particle Size (um)	***5.6***	***6.2***	***5.8***	***14.7***	***18.8***	***25.5***	***27.6***

Sample Date: May 14, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.

**Solids and Hydrocarbons expressed as mass per 100g. Fines fraction expressed as "mass of solids fraction/(mass of water + mass of solids fraction)". SFR (Sand to Fines Ratio): Sand (solids>44um) to Fines (solids <44um) ratio.

***PSD determined using Coulter Laser Diffraction method at SCL Research Dept. Reported as relative fraction of solids fraction (%).

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Table 5-3 MLSB - Elemental Content of Recycle Water and FFT Pore Water

	Surface Water [1]		Fluid Fine Tailings (FFT) Pore Water [2]							
Sample Depth (m)	***DL (ug/L)***	**0.5**	***DL (mg/kg)***	**3**	**8**	**13**	**18**	**23**	**28**	**33**
Sample Elevation (AMSL) (m)		**348.6**		**346**	**341**	**336**	**331**	**326**	**321**	**316**
Conductivity (uS/cm)		2900		4100	4300	4300	4200	4400	4400	4400
Solids Content (wt.%)		0.05		36.3	43.7	52.9	59.5	64.4	69.2	71.2
Bitumen Content (wt.%)		<0.01		9.41	4.37	1.91	2.96	2.30	1.52	1.47
Dissolved Major Elements (mg.L^{-1})**										
Sodium (Na)	***2.5***	540	***2.5***	790	900	890	870	940	960	990
Potassium (K)	***0.3***	11	***0.3***	22	17	15	14	14	14	13
Magnesium (Mg)	***0.2***	14	***0.2***	40	11	13	9.8	8.1	7.1	6.8
Calcium (Ca)	***0.3***	33	***0.3***	31	18	19	14	10	9	8.3
Boron (B)	***0.25***	1.34	***0.5***	3.25	2.36	2.03	2.39	2.45	2.53	2.33
Silicon (Si)	***0.5***	3.7	***1***	6.5	3.9	4.2	3.6	3.9	4.0	3.0
Strontium (Sr)	***0.005***	0.84	***0.01***	2.49	0.77	0.84	0.66	0.59	0.53	0.52
Sulphur (S)	***15***	169	***0.2***	3.5	4.5	6.5	5.3	7.6	9.2	13
Dissolved Trace Elements (ug.L^{-1})**										
Aluminum (Al)	***15***	22	***30***	<30	<30	<30	66	32	392	34
Antimony (Sb)	***2.5***	<2.5	***5***	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Arsenic (As)	***0.5***	11.1	***1***	3.3	29.8	28.8	35.6	33.8	31.2	31.8
Barium (Ba)	***5***	426	***10***	1820	374	403	317	283	286	239
Beryllium (Be)	***0.5***	<0.50	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	***250***	1440	***500***	3250	2360	2030	2390	2450	2530	2330
Cadmium (Cd)	***0.05***	<0.05	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium (Cr)	***5***	<5.0	***10***	<10	<10	<10	<10	<10	<10	<10
Cobalt (Co)	***1***	<1.0	***2***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Copper (Cu)	***1***	<1.0	***2***	5.7	7.5	3.3	<2.0	3.8	3.7	3.6
Iron (Fe)	***0.06***	<0.06	***0.06***	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Lead (Pb)	***1***	<1.0	***2***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Lithium (Li)	***10***	101	***20***	261	277	263	277	264	251	244
Manganese (Mn)	***0.004***	0.034	***0.004***	0.007	0.033	0.022	0.022	0.019	0.015	0.013
Mercury (Hg)	***0.002***	0.003	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum (Mo)	***5***	94.9	***10***	10	73	19	50	49	102	162
Nickel (Ni)	***5***	5.8	***10***	<10	<10	<10	<10	<10	<10	<10
Phosphorus (P)	***50***	<50	***100***	<100	103	<100	116	<100	<100	<100
Rubidium (Rb)	***10***	20	***10***	50	30	30	30	30	40	30
Selenium (Se)	***0.5***	30.7	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silicon (Si)	***500***	3710	***1000***	6540	3870	4150	3620	3850	4000	2980
Silver (Ag)	***0.1***	<0.10	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Strontium (Sr)	***5***	837	***10***	2490	767	838	664	589	533	518
Thallium (Tl)	***0.05***	<0.05	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Thorium (Th)	***5***	<5.0	***10***	<10	<10	<10	<10	<10	<10	<10
Tin (Sn)	***25***	<25	***50***	<50	<50	<50	<50	<50	<50	<50
Titanium (Ti)	***25***	<25	***50***	<50	<50	<50	<50	<50	<50	<50
Tungsten (W)	***2***	2.0	***2***	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	***0.5***	4.86	***1***	1.7	5.5	2.1	3.9	4.3	8.2	9.9
Vanadium (V)	***25***	26	***50***	<50	<50	<50	<50	<50	<50	<50
Zinc (Zn)	***25***	37	***50***	<50	<50	<50	<50	<50	<50	<50
Zirconium (Zr)	***0.5***	1.46	***1***	5.3	2.7	3.3	3.5	3.3	5.7	4.6

Sample Date: May 15, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (centrifuged and filtered).

**Dissolved: 0.45u filter-passing. Analyzed using ICP/MS (except As, Se, Sb by Hydride AA and Hg by Cold Vapour AA) by Maxxam Analytical. Major Elements expressed in mg/L, Minor Elements expressed in ug/L.

Table 5-4 MLSB - PAH Concentrations in Recycle Water and FFT

	Polycyclic Aromatic Hydrocarbons (PAH) Concentrations										
	Mol wt	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]							
Sample Depth (m)		*DL (ug/L)*	0.5	*DL (mg/kg)*	3	8	13	18	23	28	33
Sample Elevation (AMSL) (m)			**348.6**		**346**	**341**	**336**	**331**	**326**	**321**	**316**
Solids Content** (wt%)			0.05		36.3	43.7	52.9	59.5	64.4	69.2	71.2
Hydrocarbon** (wt%)			<0.01		9.41	4.37	1.91	2.96	2.30	1.52	1.47
Naphtha** (wt%)			<0.01		0.45	0.06	0.03	0.05	0.04	0.03	0.02
Polycyclic Aromatic Hydrocarbons (PAH)											
Total Parent PAH's		***0.3***	10.7	***0.01***	16.7	10.8	5.3	4.6	6.7	4.2	2.7
Total Alkylated PAH's		***0.3***	24	***0.01***	396	158	136	227	221	153	141
Alkylated PAH's as % of Total			68.9		96.0	93.6	96.3	98.0	97.0	97.3	98.1
PAH Compounds											
Quinoline	129	***0.5***	1.9	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	128	***0.1***	0.2	***0.005***	0.21	0.04	0.04	0.05	0.03	0.03	0.02
1-Methylnaphthalene	142	***0.3***		***0.005***	-	-	-	-	-	-	-
2-Methylnaphthalene	142	***0.3***	<0.3	***0.005***	0.33	0.02	0.03	0.04	0.02	0.02	0.02
C1-Naphthalene	142	***0.3***	<0.3	***0.005***	0.72	0.07	0.08	0.10	0.07	0.06	0.05
C2-Naphthalene	156	***0.3***	0.36	***0.005***	2.40	0.24	0.22	0.35	0.26	0.18	0.16
C3-Naphthalene	170	***0.3***	0.88	***0.005***	12	3.9	3.3	5.6	5.3	3.5	3.3
C4-Naphthalene	184	***0.3***	1.5	***0.005***	19	8.2	7.5	12	12	8.2	7.4
Acenaphthylene	152	***0.3***	<0.3	***0.005***	0.07	0.03	0.02	0.04	0.04	0.03	0.02
Acenaphthene	154	***0.3***	<0.3	***0.005***	0.75	0.25	0.24	0.34	0.32	0.23	0.2
C1-Acenaphthene	168	***0.1***	<0.1		-	-	-	-	-	-	-
Fluorene	166	***0.1***	0.25	***0.005***	0.39	0.14	0.20	0.24	0.24	0.16	0.14
C1-fluorene	180	***0.1***	0.54	***0.005***	3.6	1.6	1.6	2.3	2.1	1.5	1.3
C2-fluorene	194	***0.1***	1.8	***0.005***	8.8	4.0	3.8	6.0	5.8	4.0	3.6
C3-fluorene	208	***0.05***	<0.05	***0.005***	19	9.2	8.7	14	13	9.3	8.5
Biphenyl	154	***0.05***	<0.05	***0.005***	0.12	0.03	0.02	0.04	0.04	0.03	0.02
C1-biphenyl	168	***0.05***	<0.05	***0.005***	0.24	0.04	0.03	0.03	0.03	0.01	0.02
C2-biphenyl	182	***0.1***	<0.1	***0.005***	0.33	0.10	0.07	0.12	0.10	0.06	0.06
Phenanthrene	178	***0.1***	0.77	***0.005***	3.0	1.3	1.4	1.9	2.0	1.4	1.2
C1-phenanthrene/anthracene	192	***0.1***	1.5	***0.005***	13.0	5.5	6.0	8.0	8.0	5.6	5.0
C2-phenanthrene/anthracene	206	***0.1***	2.7	***0.005***	21.0	9.0	8.6	13.0	13.0	9.0	8.0
C3-phenanthrene/anthracene	220	***0.1***	0.89	***0.005***	43	19	17	27	27	19	17
C4-phenanthrene/anthracene	234	***0.03***	0.04	***0.005***	17.0	7.0	5.7	9.8	9.6	6.9	6.4
Anthracene	178	***0.03***	0.04	***0.004***	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Acridine	179	***0.1***	<0.1	***0.010***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzothiophene	184	***0.05***	<0.05	***0.005***	0.65	0.18	0.10	0.19	0.21	0.13	0.13
C1-dibenzothiophene	198	***0.05***	0.36	***0.005***	15	5.8	5.1	7.7	7.4	5.3	4.9
C2-dibenzothiophene	212	***0.05***	3.4	***0.005***	68	24	21	35	35	24	22
C3-dibenzothiophene	226	***0.05***	2.7	***0.005***	45	16	14	23	22	15	15
C4-dibenzothiophene	240	***0.05***	1.8	***0.005***	24	9.8	8.2	14	14	9.6	9.0
PAH Compounds											
Fluoranthene	202	***0.03***	0.03	***0.005***	0.14	0.14	0.11	0.17	0.17	0.13	0.13
Pyrene	202	***0.05***	0.07	***0.005***	0.81	0.38	0.31	0.49	0.45	0.33	0.3
C1-fluoranthene/pyrene	216	***0.05***	0.33	***0.005***	4.2	1.7	1.4	2.3	2.2	1.6	1.4
C2-fluoranthene/pyrene	230	***0.05***	0.64	***0.005***	12	4.8	3.6	6.7	6.2	4.4	4.1
C3-fluoranthene/pyrene	244	***0.05***	1.5	***0.005***	17	9.1	6.6	12	12	7.8	7.5
C4-fluoranthene/pyrene	258	***0.05***	0.64	***0.005***	11	5.6	4.0	8.5	7.5	5.6	4.9
Retene	234	***0.05***	0.29	***0.005***	-	-	-	-	-	-	-
Benzo(a)anthracene	228	***0.02***	<0.02	***0.005***	0.18	0.08	0.07	0.08	0.10	0.08	0.08
Chrysene	228	***0.02***	<0.02	***0.005***	<0.005	0.12	0.12	<0.005	<0.005	<0.005	<0.005
C1-benzo(a)anthracene/chrysene	242	***0.02***	0.22	***0.005***	5.1	1.7	1.3	2.4	2.3	1.6	1.5
C2-benzo(a)anthracene/chrysene	256	***0.02***	0.5	***0.005***	18	6.0	4.4	9.1	8.3	5.8	5.6
C3-benzo(a)anthracene/chrysene	270	***0.02***	0.3	***0.005***	10	3.3	2.0	4.9	4.4	3.1	2.8
C4-benzo(a)anthracene/chrysene	284	***0.02***	0.05	***0.005***	2.1	0.75	0.44	1.1	0.96	0.65	0.62
Benzo[e]pyrene	252	***0.1***	<0.1	***0.005***	0.44	0.17	0.12	0.23	0.21	0.14	0.15
Benzo(b&j)fluoranthene	252	***0.02***	<0.02	***0.005***	0.37	0.13	0.09	0.19	0.17	0.12	0.11
Benzo(k)fluoranthene	252	***0.02***	<0.02	***0.005***	<0.005	0.01	0.01	0.02	0.02	0.01	0.01
C1-benzobjkfluoranthene/benzo(a)pyrene	266	***0.02***	0.04	***0.005***	2.2	0.83	0.52	1.1	0.99	0.65	0.65
C2-benzo(bjk)fluoranthene/benzo(a)pyrene	280	***0.02***	0.07	***0.005***	2.3	0.72	0.55	1.3	1.2	0.69	0.71
Benzo(c)phenanthrene	252	***0.1***	<0.1	***0.005***	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(a)pyrene	252	***0.02***	<0.02	***0.005***	0.08	0.09	0.07	0.12	0.11	0.07	0.08
Benzo[a]pyrene (equival.)	252	***0.03***	<0.03	***0.007***	0.20	0.13	0.11	0.18	0.16	0.11	0.12
Dibenz(a,h)anthracene	278	***0.02***	<0.02	***0.005***	0.05	0.01	0.02	0.03	0.02	0.01	0.02
Perylene	252	***0.1***	<0.1	***0.005***	0.33	0.12	0.10	0.17	0.17	0.12	0.11
Benzo(g,h,i)perylene	276	***0.02***	<0.02	***0.005***	0.11	0.04	0.03	0.05	0.05	0.03	0.03
Indeno(1,2,3-cd)fluoranthene	276	***0.01***	<0.01	***0.005***	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	276	***0.02***	<0.02	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,e)pyrene	302	***0.10***	<0.1	***0.01***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)pyrene	302	***0.10***	<0.1	***0.01***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,i)pyrene	302	***0.10***	<0.1	***0.01***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,l)pyrene	302	***0.10***	<0.1	***0.01***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sample Date: May 15, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.
GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole surface water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-5 MLSB - VOC Concentrations in Recycle Water and FFT

	Volatile Organic Compound (VOC) Concentrations									
	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]							
Sample Depth (m)	*DL (ug/L)*	0.5	*DL (mg/kg)*	3	8	13	18	23	28	33
Sample Elevation (AMSL) (m)		**348.6**		**346**	**341**	**336**	**331**	**326**	**321**	**316**
F1 Hydrocarbons (C6-C10)	***100***	110	***10***	1000	190	320	230	180	170	140
F2 Hydrocarbons (C10-C16)	***100***	2.5	***10***	4300	1300	880	2100	1700	1300	1200
Volatile Organic Compounds										
1,1,1,2-tetrachloroethane	***0.5***	<0.50	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,1-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1,2,2-tetrachloroethane	***2***	<2.0	***0.25***	2.6	0.098	2.7	1.5	1.4	1.0	2.3
1,1,2-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,2,3-trichloropropane	***0.3***	<0.30	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-dibromoethane	***0.2***	<0.20	***0.05***	<0.05	<0.002	<0.0090	<0.002	<0.002	<0.004	<0.002
1,2-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,2-dichloroethane	***0.5***	<0.50	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-dichloropropane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,3-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,4-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2-Butanone (MEK)	***70***	<70	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
2-Hexanone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
4-Methyl-2-pentanone (MIBK)	***25***	<25	***1.3***	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Acetone	***50***	140	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Acrolein	***10***	<10	***10***	<10	<10	<10	<10	<10	<10	<10
Acrylonitrile	***10***	<10	***1.5***	<1.5	<0.50	<1.5	<0.75	<0.50	<0.50	<0.50
Bromodichloromethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromoform	***0.5***	<0.50	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromomethane	***2***	<2.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Carbon disulfide	***1***	<1.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Carbon tetrachloride	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	***1***	<1.0	***0.02***	<0.02	0.04	0.07	0.03	0.03	0.03	0.03
Chloroethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroform	***0.5***	2.1	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
cis-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
cis-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibromomethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dichlorodifluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ethanol	***1.0***	<1.0	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl methacrylate	***5***	<5.0	***0.25***	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Iodomethane	***4***	<4.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Trihalomethanes	***1***	2.1		-	-	-	-	-	-	-
trans-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
trans-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.03	<0.02	<0.02	<0.02	<0.02
Trichloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorofluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Vinyl chloride	***0.5***	<0.50	***0.0003***	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003

Sample Date: May 15, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.
VOC's as defined in modified headspace US EPA Protocol (Method 8260C). GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-6 MLSB - BTEX Compounds and Hydrocarbon Fractions in Recycle Water and FFT

	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]							
Sample Depth (m)	***DL (ug/L)***	**0.5**	***DL (mg/kg)***	**1**	**6**	**11**	**16**	**21**	**26**	**31**
Sample Elevation (AMSL) (m)		**348.6**		**348**	**343**	**338**	**333**	**328**	**323**	**318**
Volatile Organic Compounds (VOC's): BTEX Compounds *										
Benzene	***0.4***	<0.40	***0.005***	0.42	0.006	0.007	0.006	0.10	0.09	0.08
Ethylbenzene	***0.4***	0.88	***0.01***	0.47	0.014	<0.010	0.012	0.029	0.025	0.300
Toluene	***0.4***	<0.40	***0.02***	0.31	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
o-Xylene	***0.4***	10	***0.02***	0.58	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
m & p-Xylene	***0.8***	2.3	***0.04***	5.6	0.04	0.05	0.06	<0.04	<0.04	0.04
Xylenes (Total)	***0.89***	13	***0.05***	6.2	<0.05	0.05	0.06	<0.05	<0.05	<0.05
Hydrocarbon Fractions										
F1 (C6-C10)	***100***	110	***10***	1000	190	320	230	180	170	140
F2 (C10-C16)	***0.1***	2500	***10***	4300	1300	880	2100	1700	1300	1200
F3 (C16-C34)	***0.1***	6700	***50***	23000	5700	3200	11000	8700	6500	6000
F4 (C34-C50)	***0.2***	530	***50***	9400	2400	1100	4800	3900	2900	2700
Solids and Hydrocarbon Content **										
Solids (g/100g)		0.05		36.3	43.7	52.9	59.5	64.4	69.2	71.2
Bitumen (g/100g)		<0.01		9.41	4.37	1.91	2.96	2.30	1.52	1.47
Naphtha (g/100g)		<0.01		0.45	0.06	0.03	0.05	0.04	0.03	0.02

Sample Date: May 15, 2018. Coordinates (UTM): 6325705N, 461205E. Surface elevation: 349.1m (AMSL). FFT elevation: 347.3m.

* BTEX analysis (EPA SW-846) by Maxxam Labs, Calgary, AB using GC/MS (MeOH Ext) EPA Method 8260C. HC Fractions by EPA Method 3510C.

** OWS and Naphtha analysis performed at Syncrude Research, Edmonton. Reported as wt.%.

1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

5.2 SWSS

Syncrude

Table 5-7 SWSS - General Chemistry of Recycle Water and FFT

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) [2]				
Sample Depth (m)		1	3.5	8.5	13.5	18.5	21.2
Sample Elevation (AMSL) (m)		395.5	393.0	388.0	383.0	378.0	375.3
General							
pH (units)	1	8.65	8.66	8.63	8.51	8.51	8.55
Conductivity (uS/cm)		3835	4400	4140	4670	4600	4775
Temperature (°C)	10	20.5	15.0	9.9	8.3	7.9	8.0
Dissolved Solids (mg/L)**	15	2500	2600	1600	1800	1900	1100
Solids Content (g/100g)	0.5	0.03	23.0	31.6	37.2	52.6	48.0
Alkalinity (Total as $CaCO_3$) ($mg.L^{-1}$)**	5	745	1010	1008	985	993	927
Chemical Oxygen Demand ($mg.L^{-1}$)**	2	310	300	300	310	290	310
Biological Oxygen demand ($mg.L^{-1}$)		4	-	-	-	-	-
Dissolved Oxygen ($mg.L^{-1}$)		-	-	-	-	-	-
Redox Potential (mV)	2	240	-	-	-	-	-
Phenols ($ug.L^{-1}$)**	0.1	13	18	17	12	15	17
Tannin & Lignins (mg.L-1)**	1	1.68	1.76	1.91	1.85	1.96	2.00
Cyanide ($ug.L^{-1}$)**		<2	2.3	2.6	<2	<2	<2
MBAS ($mg.L^{-1}$)**	0.01	-	0.65	0.65	0.88	0.9	1.25
Sulphides ($ug.L^{-1}$)	2	27	26	21	17	17	16
Hydrogen Sulphide (ml/L)	2	29	28	22	18	26	21
Methane (ml/L)		-	-	-	-	-	-
Methyl Hg (ng/L)	0.02	0.09	0.03	<0.02	<0.02	<0.02	<0.02
Mercury (Hg) (ug/L)	0.002	<0.002	0.027	0.028	0.037	0.035	<0.02
Arsenic (As) (ug/L)	0.5	9.3	24.4	14.6	14.8	17.2	14.7
Selenium (Se) (ug/L)	0.5	1.00	0.59	<.5	0.78	1.06	0.99
Total Pet. Hydrocarbon ($mg.L^{-1}$)	2	2.9	6642	11190	9200	10018	18215
Bitumen Content (% by wt.)	0.01	<0.01	1.08	1.56	2.02	1.98	4.66
Naphtha Content (% by wt.)	0.01	<0.01	0.09	0.03	0.01	0.01	0.01
Total PAH's (mg/Kg)	0.002	0.01	108	122	139	178	304
Alkylated PAH's as % of Total PAH's		99	98	98	98	98	98
Dis. Inorganic Carbon (DIC) ($mgC.L^{-1}$)**	2.5	180	270	260	250	260	250
Dis. Organic Carbon (DOC) ($mgC.L^{-1}$)**	1	53	49	46	42	39	38
Naphthenic Acids ($mg.L^{-1}$)	1	67	68	65	60	56	60
Na/Cl Ratio (meq/meq)		2.4	2.4	2.1	1.7	1.7	1.6
Major Ion Ratio (∑Cat/∑An meq/meq)		1.02	0.97	0.98	0.92	0.93	0.91
Hardness (as mg/L $CaCO_3$)**		63	41	41	45	45	41
Acute Toxicity							
Rainbow Trout LC_{50} (% by vol)		>100	-	-	-	-	
Rainbow Trout (% survival at 96 hrs.)		100	-	-	-	-	
Daphnia Magna LC_{50} (% by vol)		>100	-	-	-	-	
Daphnia Magna EC_{50} (% immobility)		>100	-	-	-	-	
Microtox IC_{50} (% by vol)		>82	-	-	-	-	
Microtox IC_{20} (% by vol)		35	-	-	-	-	
Nutrients							
o-Phosphate ($ugP.L^{-1}$)	3	8.7	35	18	52	27	47
Total Phosphorous ($ugP.L^{-1}$)	3	95	40	89	36	46	43
Ammonia ($mgN.L^{-1}$)	0.015	0.94	4.90	4.90	5.70	4.60	4.60
Nitrite ($ugN.L^{-1}$)	10	90	<10	<10	<10	<10	<10
Nitrate ($ugN.L^{-1}$)	10	91	15	19	14	<10	<10
Nitrate + Nitrite ($ugN.L^{-1}$)	10	180	15	19	<10	<10	<10
Total Nitrogen ($mgN.L^{-1}$)	0.25	2.2	5.9	5.5	6.1	4.6	4.6
Silicon ($ug.L^{-1}$)	500	2500	3120	3980	3600	4080	3570
Major Ions ($mg. L^{-1}$)							
Cations ($mg. L^{-1}$)							
Sodium (Na^+)	2.5	860	980	950	1000	1000	1000
Potassium (K^+)	0.3	13	13	11	13	12	13
Magnesium (Mg^{+2})	0.2	7.90	5.5	5.5	6.4	6.5	6.0
Calcium (Ca^{+2})	0.3	12	7.2	7.3	7.2	7.2	6.5
Total Cations (meq/L)		***39.0***	***43.8***	***42.4***	***44.7***	***44.7***	***44.6***
Anions ($mg. L^{-1}$)							
Fluoride (F^-)	0.05	3.0	3.5	3.5	3.6	3.6	3.8
Chloride (Cl^-)	5	560	640	690	900	900	960
Bromide (Br^-)	0.02	0.48	0.48	0.41	0.56	0.54	0.56
Sulphate ($SO_4^=$)	5	360	320	170	160	140	170
Carbonate ($CO_3^=$)	0.5	29	48	39	23	23	30
Bicarbonate (HCO_3^-)	0.5	850	1135	1150	1155	1165	1070
Total Anions (meq/L)		***38.2***	***44.9***	***43.1***	***48.4***	***48.1***	***49.1***

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation: 394.0m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (Centrifuged and filtered).
** FFT Samples centrifuged at 30000g, then filtered (0.45u filter-passing). Naphthenic Acid, (FTIR), Bitumen and Solids (OWS), Naphtha analyses by Syncrude Research Lab.

Table 5-8 SWSS - Solids Fraction Profiles in FFT

	Fluid Fine Tailings (FFT)**				
Sample Depth (m)	**3.5**	**8.5**	**13.5**	**18.5**	**21.2**
Sample Elevation (AMSL) (m)	**393.0**	**388.0**	**383.0**	**378.0**	**375.3**
Solids Content** (g/100g)	23.0	31.6	37.2	52.6	48.0
Fines Content -*44um / (-44um+w)*	22.2	30.6	36.2	51.3	45.4
Fines Content -*22um / (-22um+w)*	20.8	29.1	33.9	48.6	43.7
Fines Content -*11um / (-11um+w)*	17.8	25.5	29.7	42.5	39.4
Fines Content -*5.5um / (-5.5um+w)*	13.5	19.9	23.5	34.3	32.3
Fines Content -2.8*um / (-2.8um+w)*	9.9	14.9	17.9	27.0	25.3
SFR** (>44um / <44um)	0.05	0.05	0.05	0.06	0.04
Bitumen (g/100g)	1.08	1.56	2.02	1.98	4.66
Naphtha (g/100g)	0.09	0.03	0.01	0.01	0.01
Calc. Density (g/ml)	1.17	1.24	1.30	1.48	1.42
Size Fraction	**Particle Size Distribution*** (% solids less than)**				
1440um	100	100	100	100	100
900um	100	100	100	100	100
720um	100	100	100	100	100
500um	100	100	100	100	100
360um	100	100	100	100	100
250um	100	100	100	100	100
180um	100	100	100	100	100
125um	100	100	100	99	100
88um	98	98	99	98	99
62um	97	97	98	97	98
44um	95	96	96	95	96
31um	92	93	91	91	94
22um	87	89	86	85	90
16um	81	83	80	77	84
11um	72	74	71	66	75
7.8um	62	64	62	56	66
5.5um	52.1	53.8	51.7	46.9	55.4
3.9um	43.3	44.9	43.2	39.1	46.4
2.8um	36.6	38.0	36.6	33.1	39.3
1.9um	29.6	30.7	29.6	26.6	31.5
1.4um	23.6	24.5	23.5	21.0	24.9
1.0um	16.8	17.4	16.6	14.7	17.3
0.7um	10.4	10.6	10.1	8.9	10.2
0.5um	5.7	5.7	5.4	4.7	5.3
0.35um	2.4	2.4	2.2	2.0	2.1
0.25um	0.81	0.76	0.68	0.60	0.57
0.18um	0.19	0.16	0.14	0.12	0.09
0.13um	0.02	0.01	0.01	0.01	0.00
0.10um	0.00	0.00	0.00	0.00	0.00
Mean Particle Size (um)	***4.6***	***4.3***	***4.6***	***5.3***	***4.1***

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation: 394.0m.
**Solids and Hydrocarbons expressed as mass per 100g. Fines fraction expressed as "mass of solids fraction/(mass of water + mass of solids fraction)". SFR (Sand to Fines Ratio): Sand (solids>44um) to Fines (solids <44um) ratio.
***PSD determined using Coulter Laser Diffraction method at SCL Research Dept.

Table 5-9 SWSS - Elemental Content of Recycle Water and FFT Pore Water

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) Pore Water [2]				
Sample Depth (m)		**1**	**3.5**	**8.5**	**13.5**	**18.5**	**21.2**
Sample Elevation (AMSL) (m)		**395.5**	**393.0**	**388.0**	**383.0**	**378.0**	**375.3**
Conductivity (uS/cm)		3835	4400	4140	4670	4600	4775
Solids Content (wt.%)		0.04	23.0	31.6	37.2	52.6	48.0
Bitumen Content (wt.%)		<0.01	1.08	1.56	2.02	1.98	4.66
Dissolved Major Elements (mg.L^{-1})**							
Sodium (Na)	***5***	860	980	950	1000	1000	1000
Potassium (K)	***0.3***	13	13	11	13	12	13
Magnesium (Mg)	***0.2***	7.9	5.5	5.5	6.4	6.5	6
Calcium (Ca)	***0.3***	12	7.2	7.3	7.2	7.2	6.5
Sulphur (S)	***0.02***	2.4	93	45	46	38	43
Boron (B)	***0.2***	110	3.76	3.65	4.02	4.53	4.32
Silicon (Si)	***0.1***	2	3.12	3.98	3.6	4.08	3.57
Strontium (Sr)	***0.02***	0.43	0.45	0.45	0.5	0.57	0.52
Dissolved Trace Elements (ug.L^{-1})**							
Aluminum (Al)	***15***	277	28	<15	18	<15	<15
Antimony (Sb)	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Arsenic (As)	***0.5***	9.3	24.4	14.6	14.8	17.2	14.7
Barium (Ba)	***5***	239	280	232	235	258	227
Beryllium (Be)	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Boron (B)	***250***	2610	3760	3650	4020	4530	4320
Cadmium (Cd)	***0.05***	0.062	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt (Co)	***1***	3.9	<1.0	1.2	1.2	1.2	<1.0
Copper (Cu)	***1***	1.2	8.5	3.1	3.2	<1.0	<1.0
Iron (Fe)	***60***	<60	<60	<60	<60	<60	<60
Lead (Pb)	***1***	1.9	<1.0	<1.0	<1.0	<1.0	<1.0
Lithium (Li)	***10***	174	216	235	268	303	308
Manganese (Mn)	***4***	9	16	13	10	8	10
Mercury (Hg)	***0.002***	<0.002	0.03	0.03	0.04	0.04	<0.02
Molybdenum (Mo)	***5***	59.1	57.1	56.1	71.3	68.8	99.6
Nickel (Ni)	***5***	10.5	<5.0	5.7	6.5	7.8	6
Phosphorus (P)	***50***	67	<50	<50	<50	51	<50
Selenium (Se)	***0.5***	1	0.59	<0.50	0.78	1.06	0.99
Silicon (Si)	***500***	2500	3120	3980	3600	4080	3570
Silver (Ag)	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Strontium (Sr)	***5***	482	452	452	496	571	521
Thallium (Tl)	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thorium (Th)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tin (Sn)	***25***	<25	<25	<25	<25	<25	<25
Titanium (Ti)	***25***	<25	<25	<25	<25	<25	<25
Uranium (U)	***0.5***	9.6	13.1	8.2	9.8	12.6	14.0
Vanadium (V)	***25***	<25	<25	<25	<25	<25	<25
Zinc (Zn)	***25***	<25	<25	<25	<25	<25	<25
Zirconium (Zr)	***0.5***	23	6.8	5.4	5.3	5.6	5.5

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation:
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (centrifuged and filtered).
**Dissolved: 0.45u filter-passing. Analyzed using ICP/MS (except As, Se, Sb by Hydride AA and Hg by Cold Vapour AA) by Maxxam Analytical. Major Elements expressed in mg/L, Minor Elements expressed in ug/L.

Table 5-10 SWSS - PAH Concentrations in Recycle Water and FFT

	Polycyclic Aromatic Hydrocarbons (PAH) Concentrations									
	Mol wt	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]						
Sample Depth (m)		*DL (ug/L)*	1	*DL (mg/kg)*	3.5	3.5	8.5	13.5	18.5	21.2
Sample Elevation (ASML) (m)			**395**		**393**	**393**	**388**	**383**	**378**	**375**
Solids Content** (wt%)			0.03		23.0	23.0	31.6	37.2	52.6	48.0
Hydrocarbon (Bitumen)** (wt%)			<0.01		1.08	1.08	1.56	2.02	1.98	4.66
Naphtha** (wt%)			<0.01		0.09	0.09	0.03	0.01	0.01	0.01
Polycyclic Aromatic Hydrocarbons (PAH)										
Total Parent PAH's			0.1		2.2	2.0	2.5	2.6	3.6	5.5
Total Alkylated PAH's			4.9		106	100	120	137	174	299
Alkylated PAH's as % of Total			99		98	98	98	98	98	98
PAH Compounds										
Quinoline	*129*	***0.20***	<0.20	***0.01***	0.11	0.10	0.53	0.12	0.16	0.30
Naphthalene	*128*	***0.10***	<0.10	***0.005***	0.02	0.02	0.02	0.02	0.03	0.04
2-Methylnaphthalene	*142*	***0.10***	<0.10	***0.005***	0.01	0.01	0.01	<0.005	<0.005	<0.005
C1-Naphthalene	*142*	***0.10***	<0.10	***0.005***	0.03	0.03	0.04	0.03	0.04	0.07
C2-Naphthalene	*156*	***0.10***	<0.10	***0.005***	0.10	0.09	0.16	0.07	0.10	0.22
C3-Naphthalene	*170*	***0.10***	0.13	***0.005***	1.7	1.5	1.6	0.88	1.9	5.3
C4-Naphthalene	*184*	***0.10***	0.28	***0.005***	4.8	4.5	4.9	4.8	7.9	12
Acenaphthylene	*152*	***0.10***	<0.10	***0.005***	0.02	0.02	0.03	0.03	0.04	0.08
Acenaphthene	*154*	***0.10***	<0.10	***0.005***	0.21	0.20	0.19	0.19	0.27	0.35
Fluorene	*166*	***0.05***	<0.05	***0.005***	0.10	0.09	0.10	0.10	0.26	0.40
C1-fluorene	*180*	***0.05***	0.072	***0.005***	0.80	0.71	0.80	0.91	1.7	2.5
C2-fluorene	*194*	***0.05***	0.19	***0.005***	2.2	2.1	2.4	2.8	4.2	7.3
C3-fluorene	*208*	***0.05***	0.52	***0.005***	6.7	5.9	7.0	8.5	10.0	17.0
Biphenyl	*154*	***0.02***	<0.02	***0.005***	<0.005	0.01	0.02	0.01	0.02	0.03
C1-biphenyl	*168*	***0.02***	<0.02	***0.005***	0.01	0.01	0.01	0.01	0.02	0.03
C2-biphenyl	*182*	***0.02***	0.03	***0.005***	0.04	0.04	0.05	0.07	0.09	0.19
Phenanthrene	*178*	***0.05***	<0.05	***0.005***	0.46	0.43	0.28	0.02	0.43	0.09
C1-phenanthrene/anthracene	*192*	***0.05***	<0.05	***0.005***	3.1	2.9	2.1	0.4	2.6	1.8
C2-phenanthrene/anthracene	*206*	***0.05***	0.11	***0.005***	5.9	5.6	5.2	4.6	8.3	14.0
C3-phenanthrene/anthracene	*220*	***0.05***	0.22	***0.005***	11.0	11.0	13.0	15.0	19.0	34.0
C4-phenanthrene/anthracene	*234*	***0.05***	0.19	***0.005***	4.8	4.5	6.0	7.3	7.7	13.0
Anthracene	*178*	***0.01***	<0.01	***0.004***	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Acridine	*179*	***0.05***	<0.05	***0.01***	0.33	0.30	0.27	0.34	0.59	0.84
Dibenzothiophene	*184*	***0.02***	<0.02	***0.005***	0.08	0.08	0.18	0.36	0.38	0.88
C1-dibenzothiophene	*198*	***0.02***	<0.02	***0.005***	3.2	3.1	3.0	3.1	5.6	8.3
C2-dibenzothiophene	*212*	***0.02***	0.38	***0.005***	15.0	14.0	16.0	18.0	28.0	46.0
C3-dibenzothiophene	*226*	***0.02***	0.19	***0.005***	13.0	12.0	15.0	16.0	20.0	35.0
C4-dibenzothiophene	*240*	***0.02***	0.17	***0.005***	8.4	7.8	10.0	11.0	13.0	23.0
Fluoranthene	*202*	***0.01***	<0.01	***0.005***	0.07	0.06	0.09	0.12	0.13	0.25
Pyrene	*202*	***0.02***	0.036	***0.005***	0.24	0.22	0.26	0.38	0.41	0.71
C1-fluoranthene/pyrene	*216*	***0.02***	0.22	***0.005***	1.1	1.1	1.4	2.0	2.1	3.0
C2-fluoranthene/pyrene	*230*	***0.02***	0.47	***0.005***	3.1	3.0	4.0	5.4	5.5	9.8
C3-fluoranthene/pyrene	*244*	***0.02***	0.71	***0.005***	8.0	7.4	10.0	14.0	14.0	25.0
C4-fluoranthene/pyrene	*258*	***0.02***	0.33	***0.005***	5.6	5.2	7.4	9.4	9.4	17.0
Benzo(a)anthracene	*228*	***0.01***	<0.001	***0.005***	0.05	0.05	0.05	0.05	0.06	0.10
Chrysene	*228*	***0.01***	<0.001	***0.005***	0.06	0.07	0.04	0.11	0.11	0.15
C1-benzo(a)anthracene/chrysene	*242*	***0.01***	0.18	***0.005***	0.94	0.89	1.1	1.5	1.7	3.0
C2-benzo(a)anthracene/chrysene	*256*	***0.01***	0.25	***0.005***	3.4	3.1	4.1	5.5	5.6	11.0
C3-benzo(a)anthracene/chrysene	*270*	***0.01***	0.13	***0.005***	1.7	1.6	2.2	2.9	3.0	5.5
C4-benzo(a)anthracene/chrysene	*284*	***0.01***	0.022	***0.005***	0.44	0.42	0.61	0.76	0.77	1.40
Benzo[e]pyrene	*252*	***0.05***	<0.05	***0.005***	0.10	0.10	0.12	0.18	0.18	0.30
Benzo(b&j)fluoranthene	*252*	***0.01***	0.011	***0.005***	0.07	0.07	0.08	0.12	0.13	0.24
Benzo(k)fluoranthene	*252*	***0.01***	<0.001	***0.005***	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
C1-benzobjkfluoranthene/benzo(a)pyrene	*266*	***0.01***	0.068	***0.005***	0.48	0.52	0.66	0.83	0.95	1.50
C2-benzo(bjk)fluoranthene/benzo(a)pyrene	*280*	***0.01***	0.07	***0.005***	0.61	0.64	0.84	1.10	1.10	1.80
Benzo(c)phenanthrene	*252*	***0.05***	<0.05	***0.005***	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(a)pyrene	*252*	***0.01***	<0.001	***0.005***	0.05	0.05	0.05	0.08	0.08	0.14
Benzo[a]pyrene (equival.)	*252*	***0.01***	0.01	***0.005***	0.08	0.00	0.09	0.13	0.13	0.24
Dibenz(a,h)anthracene	*278*	***0.01***	<0.001	***0.005***	0.02	0.02	0.02	0.03	0.03	0.06
Perylene	*252*	***0.05***	<0.05	***0.005***	0.07	0.07	0.08	0.13	0.13	0.23
Benzo(g,h,i)perylene	*276*	***0.01***	<0.001	***0.005***	0.04	0.04	0.04	0.07	0.07	0.09
Indeno(1,2,3-cd)pyrene	*276*	***0.01***	<0.001	***0.005***	0.02	0.02	0.02	0.04	0.04	0.07
Dibenzo(a,e)pyrene	*302*	***0.10***	<0.1	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)pyrene	*302*	***0.10***	<0.1	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,i)pyrene	*302*	***0.10***	<0.1	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,l)pyrene	*302*	***0.01***	<0.1	***0.01***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation: 394.0m.
GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole surface water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

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Table 5-11 SWSS - VOC Concentrations in Recycle Water and FFT

	Volatile Organic Compound (VOC) Concentrations							
	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]					
Sample Depth (m)	*DL (ug/L)*	1	*DL (mg/kg)*	3.5	8.5	13.5	18.5	21.2
Sample Elevation (ASML) (m)		395		393	388	383	378	375
F1 Hydrocarbons (C6-C10)	***100***	<100	***10***	42	90	<10	18	15
F2 Hydrocarbons (C10-C16)	***100***	620	***10***	900	1300	1100	1300	2200
Volatile Organic Compounds								
1,1,1,2-tetrachloroethane	***0.5***	<0.50	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,1-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1,2,2-tetrachloroethane	***2***	<2.0	***0.3***	<0.30	<0.30	<0.05	<0.20	<0.10
1,1,2-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,2,3-trichloropropane	***0.3***	<0.30	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-dibromoethane	***0.2***	<0.20	***0.002***	<0.002	0.003	<0.002	<0.002	<0.002
1,2-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,2-dichloroethane	***0.5***	<0.50	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-dichloropropane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,3-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,4-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
2-Butanone (MEK)	***70***	<70	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
2-Hexanone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
4-Methyl-2-pentanone (MIBK)	***25***	<25	***1.3***	<1.3	<1.3	<1.3	<1.3	<1.3
Acetone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
Acrolein	***10***	<10	***1***	<1.0	<1.0	<1.0	<1.0	<1.0
Acrylonitrile	***10***	<10	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Bromoform	***0.5***	<0.50	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05
Bromomethane	***2***	<2.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Carbon disulfide	***1***	<1.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
Carbon tetrachloride	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroform	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
cis-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
cis-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Dibromomethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Dichlorodifluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Ethanol	***1***	<1.0	***1***	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl methacrylate	***5***	<5.0	***0.25***	0.63	2	<0.25	<0.25	<0.25
Iodomethane	***4***	<4.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Total Trihalomethanes	***1.3***	<1.3	***-***	-	-	-	-	-
trans-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
trans-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Trichloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorofluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Vinyl chloride	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation:

VOCs as defined in modified headspace US EPA Protocol (Method 8260C). GC/MS analyses performed by Maxxam Analytics, Calgary, AB.

1) Surface Zone: Concentrations reported as ug per L of whole water sample.

2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

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Table 5-12 SWSS - BTEX Compounds and Hydrocarbon Fractions in Recycle Water and FFT

	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]					
Sample Depth (m)	***DL (ug/L)***	**1**	***DL (mg/kg)***	**3.5**	**8.5**	**13.5**	**18.5**	**21.2**
Sample Elevation (AMSL) (m)		**395.5**		**393.0**	**388.0**	**383.0**	**378.0**	**375.3**
Volatile Organic Compounds (VOC's): BTEX Compounds *								
Benzene	***0.4***	<0.4	***0.005***	0.007	0.021	<0.0050	<0.0050	<0.0050
Ethylbenzene	***0.4***	<0.4	***0.01***	<0.010	0.096	<0.010	<0.010	<0.010
Toluene	***0.4***	1.3	***0.02***	<0.020	<0.020	<0.020	<0.020	<0.020
o-Xylene	***0.4***	<0.4	***0.02***	<0.020	0.035	<0.020	<0.020	<0.020
m & p-Xylene	***0.8***	<0.8	***0.04***	<0.040	0.28	<0.040	<0.040	<0.040
Xylenes (Total)	***0.9***	<0.9	***0.045***	<0.045	0.31	<0.045	<0.045	<0.045
Hydrocarbon Fractions								
F1 (C6-C10)	***100***	<100	***10***	42	90	<10	18	15
F2 (C10-C16)	***100***	620	***10***	900	1300	1100	1300	2200
F3 (C16-C34)	***100***	2300	***50***	4000	6700	5700	6100	11000
F4 (C34-C50)	***200***	<200	***50***	1700	3100	2400	2600	5000
F4G-SG (Heavy Hydrocarbons-Grav.)		-	***200***	9100	17000	13000	14000	30000
Solids and Hydrocarbon Content **								
Solids (g/100g)		0.03		23.0	31.6	37.2	52.6	48.0
Bitumen (g/100g)		<0.01		1.08	1.56	2.02	1.98	4.66
Naphtha (g/100g)		<0.01		0.09	0.03	0.01	0.01	0.01

Sample Date: August 3, 2018. Coordinates (UTM): 6314580N, 453810E. Surface elevation: 396.5m (AMSL). FFT elevation:
* BTEX analysis (EPA SW-846) by Maxxam Laboratories, Calgary, AB using GC/MS (MeOH Ext). EPA Method 8260C. HC Fractions by EPA Method 3510C.
** OWS and Naphtha analysis performed at Syncrude Research, Edmonton. Reported as wt.%.
1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

5.3 SWIP

Table 5-13 SWIP - General Chemistry of Recycle Water and FFT

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) [2]			
Sample Depth (m)		1	5.7	10.7	15.7	20.7
Sample Elevation (AMSL) (m)		312.3	307.6	302.6	297.6	292.6
General						
pH (units)		8.34	8.57	8.6	8.55	**8.47**
Conductivity (uS/cm)	*1*	4100	4510	4150	4060	4350
Temperature (°C)		17.9	8.8	14.0	16.2	48
Dissolved Solids (mg/L)**	*10*	2000	2400	2500	2100	2800
Solids Content (g/100g)		0.05	12.8	28.7	36.9	57.7
Alkalinity (Total as $CaCO_3$) (mg.L^{-1})**	*0.5*	779	858	1240	1254	1059
Chemical Oxygen Demand (mg.L^{-1})**	*5*	360	280	260	280	250
Biological Oxygen demand (mg.L^{-1})	*2*	7	-	-	-	-
Dissolved Oxygen (mg.L^{-1})		-	-	-	-	-
Redox Potential (mV)		270	-	-	-	-
Phenols (ug.L^{-1})**	*2*	11	15	18	13	15
Tannin & Lignins (mg.L-1)**	*0.4*	2.13	1.53	1.96	1.95	1.68
Cyanide (ug.L^{-1})**	*10*	2.2	3.4	<2	<2	<2
MBAS (mg.L^{-1})**	*0.1*		0.43	0.48	0.54	0.62
Sulphides (mg.L^{-1})	*0.01*	0.01	0.02	0.09	0.04	0.07
Hydrogen Sulphide (ml/L)	*0.01*	0.01		0.1	0.04	0.08
Methane (ml/L)	*0.8*					-
Methyl Hg (ng/L)	*0.02*	<0.02	<0.02	0.03	<0.02	<0.02
Mercury (Hg) (ug/L)	*0.002*	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic (As) (ug/L)	*0.2*	10.0	8.6	57.6	12.3	9.2
Selenium (Se) (ug/L)	*0.2*	10.3	5.9	0.9	<0.50	<0.50
Total Pet. Hydrocarbon (mg.L^{-1})	*2*	14.8	7230	24500	31400	58900
Bitumen Content (% by wt.)	*0.01*	<0.01	0.47	1.71	2.14	4.49
Naphtha Content (% by wt.)	*0.01*	<0.01	<0.01	0.01	0.04	0.03
Total PAH's (mg/L)	*0.001*	0.01	51	129	183	285
Alkylated PAH's as % of Total PAH's		99	98	99	98	99
Dis. Inorganic Carbon ((mgC.L^{-1})**	*1*	170	210	290	290	270
Dis. Organic Carbon (mgC.L^{-1})**	*2.5*	42	40	44	44	42
Naphthenic Acids (mg.L^{-1})	*2*	73	87	82	84	90
Citrate (mg.L^{-1})	*1*	<1	<1	<1	<1	<1
Na/Cl Ratio (meq/meq)		2.37	2.34	2.49	2.40	2.63
Major Ion Ratio (∑Cat/∑An meq/meq)		1.02	1.01	1.01	1.03	1.02
Hardness (as mg/L $CaCO_3$)**		48.9	58.4	52.0	72.1	80.8
Acute Toxicity						
Rainbow Trout LC_{50} (% by vol)		29	-	-	-	-
Rainbow Trout (% survival at 96 hrs.)		0	-	-	-	-
Daphnia Magna LC_{50} (% by vol)		>100	-	-	-	-
Daphnia Magna EC_{50} (% immobility)		100	-	-	-	-
Microtox IC_{50} (% by vol)		57	-	-	-	-
Microtox IC_{20} (% by vol)		18	-	-	-	-
Nutrients						
o-Phosphate (ugP.L^{-1})	*3*	49	73	100	220	57
Total Phosphorous (ugP.L^{-1})	*3*	120	10	110	180	65
Ammonia (mgN.L^{-1})	*0.1*	5	5.7	5.1	7.6	**6**
Nitrite (ugN.L^{-1})	*10*	24	<10	<10	<10	<10
Nitrate (ugN.L^{-1})	*10*	17	<10	<10	25	<10
Nitrate + Nitrite (ugN.L^{-1})	*3*	41	<10	<10	25	<10
Total Nitrogen (mgN.L^{-1})	*0.25*	6.7	6.6	6.3	8.1	5.9
Silicon (mg.L^{-1})	*0.1*	1.8	1.4	3.5	3.9	3.2
Major Ions (mg. L^{-1})						
Cations (mg. L^{-1})						
Sodium (Na^+)	*2.5*	1000	1075	1015	1010	1090
Potassium (K^+)	*0.3*	11	14	12	11	13
Magnesium (Mg^{+2})	*0.2*	6.7	8.2	6.9	7.1	9.2
Calcium (Ca^{+2})	*0.3*	8.4	9.7	9.3	17	17
Total Cations (meq/L)		***44.7***	***48.3***	***45.5***	***45.6***	***49.3***
Anions (mg. L^{-1})						
Fluoride (F^-)	*0.05*	3.4	3.1	2.5	3.5	2.9
Chloride (Cl^-)	*5*	650	710	630	650	640
Bromide (Br^-)	*0.02*	0.51	0.52	0.45	0.4	0.49
Sulphate ($SO_4^=$)	*5*	470	500	130	41	440
Carbonate ($CO_3^=$)	*0.5*	15	28	43	39	45
Bicarbonate (HCO_3^-)	*0.5*	920	990	1425	1450	1200
Total Anions (meq/L)		***43.7***	***47.6***	***45.2***	***44.2***	***48.4***

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL).
FFT elevation: 308.6m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (centrifuged and filtered).
** Samples centrifuged at 30000g, then filtered (0.45u filter-passing).

Table 5-14 SWIP - Solids Fraction Profiles in FFT

	Fluid Fine Tailing (FFT)**			
Sample Depth (m)	**5.7**	**10.7**	**15.7**	**20.7**
Sample Elevation (AMSL) (m)	**307.6**	**302.6**	**297.6**	**292.6**
Solids Content** (g/100g)	12.8	28.7	36.9	57.7
Fines Content -44*um / (-44um+w)*	12.8	28.4	36.5	47.3
Fines Content -*22um / (-22um+w)*	12.7	26.7	35.0	42.1
Fines Content -*11um / (-11um+w)*	11.0	22.3	31.6	35.7
Fines Content -*5.5um / (-5.5um+w)*	8.6	16.7	25.6	30.2
Fines Content -2.8*um / (-2.8um+w)*	5.8	12.3	19.8	23.1
SFR** (>44um / <44um)	0.00	0.04	0.07	0.71
Bitumen (g/100g)	0.47	1.71	2.14	4.49
Naphtha (g/100g)	0.00	0.01	0.04	0.03
Calc. Density (g/ml)	1.09	1.22	1.30	1.56
Size Fraction	**Particle Size Distribution*** (% solids less than)**			
1440um	100	100	100	100
900um	100	100	100	100
720um	100	100	100	100
500um	100	100	100	100
360um	100	100	100	100
250um	100	100	100	100
180um	100	100	100	92
125um	100	100	98	77
88um	100	99	96	69
62um	100	98	95	64
44um	100	97	94	58
31um	99	94	91	52
22um	98	89	88	47
16um	93	81	83	42
11um	83	70	75	36
7.8um	74	59	66	32
5.5um	63	49	56	28
3.9um	51	40	47	24
2.8um	42	34	40	20
1.9um	32	27	33	15
1.4um	25	22	26	12
1.0um	18.6	15.5	18.1	8.0
0.7um	12.2	9.6	10.9	4.8
0.5um	7.3	5.4	5.7	2.6
0.35um	3.5	2.4	2.3	1.1
0.25um	1.35	0.82	0.70	0.34
0.18um	0.39	0.21	0.14	0.07
0.13um	0.06	0.03	0.01	0.00
0.10um	0.00	0.00	0.00	0.00
Mean Particle Size (um)	***3.3***	***4.8***	***4.3***	***19.6***

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL). FFT elevation: 308.6m.

**Solids and Hydrocarbons expressed as mass per 100g. Fines fraction expressed as "mass of solids fraction/(mass of water + mass of solids fraction)". SFR (Sand to Fines Fraction): Sand (solids>44um) to Fines (solids <44um)
***PSD determined using Coulter Laser Diffraction method at SCL Research Dept. Reported as relative fraction of solids fraction (%).

Table 5-15 SWIP - Elemental Content of Recycle Water and FFT Pore Water

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) Pore Water [2]			
Sample Depth (m)		**1**	**5.7**	**10.7**	**15.7**	**20.7**
Sample Elevation (AMSL) (m)		**312.3**	**307.6**	**302.6**	**297.6**	**292.6**
Conductivity (uS/cm)		4200	4600	4200	4100	4700
Solids Content (wt.%)		0.05	12.8	28.7	36.9	57.7
Bitumen Content (wt.%)		<0.01	0.47	1.71	2.14	4.49
Dissolved Major Elements (mg.L^{-1})**						
Sodium (Na)	***2.5***	900	1000	930	900	1000
Potassium (K)	***0.3***	11	14	12	11	13
Magnesium (Mg)	***0.2***	6.7	8.2	6.9	7.1	9.2
Calcium (Ca)	***0.3***	8.4	9.7	9.3	17	17
Sulphur (S)	***15***	150	145	34.7	<15	127
Boron (B)	***0.25***	2.08	1.9	2.5	2.5	2.47
Strontium (Sr)	***0.005***	0.44	0.49	0.45	0.52	0.64
Silicon (Si)	***0.5***	1.82	1.37	3.48	3.93	3.22
Dissolved Trace Elements (ug.L^{-1})**						
Aluminum (Al)	***15***	15	52	34	<15	<15
Antimony (Sb)	***2.5***	<2.5	<2.5	6.9	<2.5	3.1
Arsenic (As)	***0.5***	10	8.6	21.2	12.3	9.2
Barium (Ba)	***5***	248	276	361	420	111
Beryllium (Be)	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50
Boron (B)	***250***	2080	1900	2500	2500	2470
Cadmium (Cd)	***0.05***	<0.05	<0.050	<0.050	<0.050	<0.050
Chromium (Cr)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt (Co)	***1***	1.3	1.5	<1.0	<1.0	<1.0
Copper (Cu)	***1***	<1.0	3.5	1.7	2.6	<1.0
Iron (Fe)	***60***	<60	<60	<60	<60	<60
Lead (Pb)	***1***	<1.0	<1.0	<1.0	<1.0	<1.0
Lithium (Li)	***10***	160	169	153	166	181
Manganese (Mn)	***4***	21	22	13	19	<4
Mercury (Hg)	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002
Molybdenum (Mo)	***5***	105	111	<5.0	5	<5.0
Nickel (Ni)	***5***	6.9	6	11.7	<5.0	<5.0
Phosphorus (P)	***50***	<50	<50	86	149	<50
Rubidium (Rb)	***10***	20	30	20	20	30
Selenium (Se)	***0.5***	10.3	5.9	0.9	<0.50	<0.50
Silicon (Si)	***500***	1820	1370	3480	3930	3220
Silver (Ag)	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10
Strontium (Sr)	***5***	437	491	447	516	638
Thallium (Tl)	***0.05***	<0.05	<0.050	<0.050	<0.050	<0.050
Thorium (Th)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0
Tin (Sn)	***25***	<25	<25	<25	<25	<25
Titanium (Ti)	***25***	<25	<25	<25	<25	<25
Tunsgten (W)	***2***	3	2	<2	<2	<2
Uranium (U)	***0.5***	14.1	15.6	4.49	2.73	5.42
Vanadium (V)	***25***	<25	<25	<25	<25	<25
Zinc (Zn)	***25***	<25	<25	<25	<25	<25
Zirconium (Zr)	***0.5***	5.64	6.1	3.78	2.89	2.87

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL). FFT elevation: 308.6m.

1) Free Water Zone above FFT interface (0.45u filter-passing).

2) Fine Tails Pore Water (centrifuged and filtered).

**Dissolved: 0.45u filter-passing. Analyzed using ICP/MS (except As, Se, Sb by Hydride AA and Hg by Cold Vapour AA) by Maxxam Analytical. Major Elements expressed in mg/L, Minor Elements expressed in ug/L.

Table 5-16 SWIP - PAH Concentrations in Recycle Water and FFT

	Polycyclic Aromatic Hydrocarbons (PAH) Concentrations								
	Mol wt	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]					
Sample Depth (m)		*DL (ug/L)*	**1**	*DL (mg/kg)*	**5.7**	**10.7**	**15.7**	**20.7**	**20.7**
Sample Elevation (ASML) (m)			**312.3**		**307.6**	**302.6**	**297.6**	**292.6**	**292.6**
Solids Content** (wt%)			<0.05		12.8	28.7	36.9	57.7	57.7
Hydrocarbon** (wt%)			<0.01		0.47	1.71	2.14	4.49	4.49
Naphtha** (wt%)			<0.01		0.00	0.01	0.04	0.03	0.03
Polycyclic Aromatic Hydrocarbons (PAH)									
Total Parent PAH's		***0.01***	0.06		0.8	1.8	2.8	4.0	3.9
Total Alkylated PAH's		***0.01***	6.3		50	128	180	281	283
Alkylated PAH's as % of Total			99		98	99	98	99	99
PAH Compounds									
Quinoline	129	***0.2***	<0.20	***0.005***	<0.005	0.01	0.03	0.02	0.02
Naphthalene	128	***0.1***	<0.10	***0.005***	<0.005	<0.005	0.02	0.01	0.01
2-Methylnaphthalene	142	***0.1***	<0.10	***0.005***	0.01	0.02	0.08	0.07	0.08
C1-Naphthalene	142	***0.1***	<0.10	***0.005***	0.03	0.09	0.35	0.23	0.23
C2-Naphthalene	156	***0.1***	<0.10	***0.005***	0.53	1.9	3.4	5.9	6
C3-Naphthalene	170	***0.1***	0.16	***0.005***	2.1	5.8	8.6	14	14
C4-Naphthalene	184	***0.1***	0.29	***0.005***	0.01	0.02	0.04	0.05	0.06
Acenaphthylene	152	***0.1***	<0.10	***0.005***	0.08	0.19	0.30	0.45	0.47
Acenaphthene	154	***0.1***	<0.10	***0.005***	0.02	0.10	0.15	0.29	0.30
Fluorene	166	***0.05***	<0.05	***0.005***	0.4	0.98	1.4	2.2	2.1
C1-fluorene	180	***0.05***	0.07	***0.005***	1.1	2.9	4.1	5.6	5.4
C2-fluorene	194	***0.05***	0.13	***0.005***	3.1	8.1	11	17	16
C3-fluorene	208	***0.05***	0.77	***0.005***	0.01	0.03	0.03	0.04	0.04
Biphenyl	154	***0.02***	<0.02	***0.005***	0.01	0.02	0.05	0.05	0.06
C1-biphenyl	168	***0.02***	<0.02	***0.005***	0.02	0.05	0.07	0.10	0.10
C2-biphenyl	182	***0.02***	0.04	***0.005***	0.25	0.03	0.19	0.02	0.01
Phenanthrene	178	***0.05***	<0.05	***0.005***	1.7	1	3.1	3.5	3.6
C1-phenanthrene/anthracene	192	***0.05***	0.12	***0.005***	3.1	5.3	9	15	15
C2-phenanthrene/anthracene	206	***0.05***	0.19	***0.005***	6.5	16	22	34	36
C3-phenanthrene/anthracene	220	***0.05***	0.42	***0.005***	2.2	6.8	9	13	13
C4-phenanthrene/anthracene	234	***0.05***	0.21	***0.004***	<0.004	0.11	0.15	0.24	0.27
Anthracene	178	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	179	***0.05***	<0.05	***0.005***	0.02	0.11	0.31	0.48	0.45
Dibenzothiophene	184	***0.02***	<0.02	***0.005***	2.2	4.3	6	9.8	9.4
C1-dibenzothiophene	198	***0.02***	<0.02	***0.005***	7.2	19	27	43	42
C2-dibenzothiophene	212	***0.02***	0.64	***0.005***	5.6	14	19	32	32
C3-dibenzothiophene	226	***0.02***	0.25	***0.005***	3.8	9.7	13	19	19
C4-dibenzothiophene	240	***0.02***	0.28	***0.005***	0.03	0.13	0.16	0.21	0.23
Fluoranthene	202	***0.01***	<0.01	***0.005***	0.11	0.33	0.45	0.65	0.71
Pyrene	202	***0.02***	0.04	***0.005***	0.51	1.5	2.1	3.3	3.4
C1-fluoranthene/pyrene	216	***0.02***	0.23	***0.005***	1.4	4.5	6	9.7	10
C2-fluoranthene/pyrene	230	***0.02***	0.47	***0.005***	3.2	8.4	11	18	18
C3-fluoranthene/pyrene	244	***0.02***	0.93	***0.005***	1.8	5.1	7.3	11	11
C4-fluoranthene/pyrene	258	***0.02***	0.38	***0.005***	-	-	-	-	-
Retene	234	***0.05***	<0.05	***0.005***	0.02	0.07	0.07	0.11	0.12
Benzo(a)anthracene	228	***0.01***	<0.01	***0.005***	0.05	<0.005	<0.005	<0.005	<0.005
Chrysene	228	***0.01***	<0.01	***0.005***	0.49	1.5	2	2.9	3.6
C1-benzo(a)anthracene/chrysene	242	***0.01***	0.15	***0.005***	1.7	5.5	7.4	11	12
C2-benzo(a)anthracene/chrysene	256	***0.01***	0.26	***0.005***	0.88	2.9	4	6.2	6.2
C3-benzo(a)anthracene/chrysene	270	***0.01***	0.14	***0.005***	0.25	0.72	0.95	1.6	1.8
C4-benzo(a)anthracene/chrysene	284	***0.01***	0.03	***0.005***	0.05	0.16	0.22	0.30	0.32
Benzo[e]pyrene	252	***0.05***	<0.05	***0.005***	0.035	0.12	0.16	0.25	0.28
Benzo(b&j)fluoranthene	252	***0.01***	0.02	***0.005***	<0.005	0.01	0.01	0.02	0.02
Benzo(k)fluoranthene	252	***0.01***	<0.01	***0.005***	0.23	0.75	1	1.4	1.6
C1-benzo(bjk)fluoranthene/benzo(a)pyrene	266	***0.01***	0.06	***0.005***	0.32	0.81	1.1	1.7	1.6
C2-benzo(bjk)fluoranthene/benzo(a)pyrene	280	***0.01***	0.04	***0.005***	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo(c)phenanthrene	252	***0.05***	<0.05	***0.005***	0.02	0.09	0.12	0.15	0.16
Benzo(a)pyrene	252	***0.01***	<0.01	***0.0071***	0.04	0.13	0.18	0.26	-
Benzo[a]pyrene (equival.)	252	***0.01***	0.01	***0.005***	0.01	0.02	0.03	0.05	0.05
Dibenz(a,h)anthracene	278	***0.01***	<0.01	***0.005***	0.04	0.12	0.16	0.24	0.24
Perylene	252	***0.05***	<0.05	***0.005***	0.02	0.05	0.06	0.10	0.08
Benzo(g,h,i)perylene	276	***0.01***	<0.01	***0.005***	0.01	0.03	0.03	0.10	0.09
Indeno(1,2,3-cd)pyrene	276	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,e)pyrene	302	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)pyrene	302	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,i)pyrene	302	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,l)pyrene	302	***0.01***	<0.01	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL). FFT elevation: 308.6m.
GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole surface water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-17 SWIP - VOC Concentrations in Recycle Water and FFT

	Volatile Organic Compound (VOC) Concentrations							
	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]					
Sample Depth (m)	*DL (ug/L)*	1	*DL (mg/kg)*	5.7	10.7	15.7	20.7	20.7
Sample Elevation (ASML) (m)		312.3		307.6	302.6	297.6	292.6	292.6
F1 Hydrocarbons (C6-C10)	***100***	<100	***10***	<10	16	120	67	65
F2 Hydrocarbons (C10-C16)	***0.1***	2800	***10***	410	1200	1600	2900	3100
Volatile Organic Compounds								
1,1,1-trichloroethane	***0.5***	<0.50	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,1,2-tetrachloroethane	***0.5***	<0.50	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,1-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1,2,2-tetrachloroethane	***2***	<2.0	***0.05***	<0.05	0.15	0.098	<1.0	<1.0
1,1,2-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,2,3-trichloropropane	***0.3***	<0.30	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-dibromoethane	***0.23***	<0.23	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,2-dichloroethane	***0.5***	<0.50	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-dichloropropane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,3-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
1,4-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
2-Butanone (MEK)	***70***	<70	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
2-Hexanone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
4-Methyl-2-pentanone (MIBK)	***25***	<25	***1.3***	<1.3	<1.3	<1.3	<1.3	<1.3
Acetone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5
Acrolein	***10***	<10	***10***	<10	<10	<10	<10	<10
Acrylonitrile	***10***	<10	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Bromoform	***0.5***	<0.50	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05
Bromomethane	***2***	<2.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Carbon disulfide	***1***	<1.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
Carbon tetrachloride	***0.5***	<0.50	***0.0005***	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chlorobenzene	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorodibromomethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroform	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
cis-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
cis-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Dibromomethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Dichlorodifluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03
Ethanol	***1***	<1.0	***1.0***	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl methacrylate	***5***	<5.0	***0.25***	<0.25	<0.25	<0.25	<0.25	<0.25
Iodomethane	***4***	<4.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Total Trihalomethanes	***1.3***	<1.3	***-***	-	-	-	-	-
trans-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
trans-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Trichloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorofluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
Vinyl chloride	***0.5***	<0.50	***0.0003***	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL). FFT elevation: VOCs as defined in modified headspace US EPA Protocol (Method 8260C). GC/MS analyses performed by Maxxam Analytics, Calgary, AB. Hydrocarbon Fractions (F1, F2) by EPA Method 3510C.

1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-18 SWIP - BTEX Compounds and Hydrocarbon Fractions in Recycle Water and FFT

	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]					
Sample Depth (m)	***DL (ug/L)***	**1**	***DL (mg/kg)***	**5.7**	**10.7**	**15.7**	**20.7**	**20.7**
Sample Elevation (AMSL) (m)		**312.3**		**307.6**	**302.6**	**297.6**	**292.6**	**292.6**
Volatile Organic Compounds (VOC's): BTEX Compounds *								
Benzene	***0.4***	<0.40	***0.005***	<0.005	<0.005	<0.005	0.019	0.018
Ethylbenzene	***0.4***	<0.40	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	***0.4***	<0.40	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
o-Xylene	***0.4***	<0.40	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02
m & p-Xylene	***0.8***	<0.80	***0.04***	<0.04	<0.04	<0.04	<0.04	<0.04
Xylenes (Total)	***0.9***	<0.90	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05
Hydrocarbon Fractions								
F1 (C6-C10)	***100***	<100	***10***	<10	16	120	67	65
F2 (C10-C16)	***100***	2800	***10***	410	1200	1600	2900	3100
F3 (C16-C34)	***100***	12000	***50***	1900	6400	8100	15000	15000
F4 (C34-C50)	***200***	<200	***50***	820	2900	3700	7000	6900
F4G-SG (Heavy Hydrocarbons-Grav.)		-	***500***	4100	14000	18000	34000	
Solids and Hydrocarbon Content **								
Solids (g/100g)		<0.05		12.8	28.7	36.9	57.7	57.7
Bitumen (g/100g)		<0.01		0.47	1.71	2.14	4.49	4.49
Naphtha (g/100g)		<0.01		0.00	0.01	0.04	0.03	0.03

Sample Date: May 22, 2018. Coordinates (UTM): 6317240N, 459385E. Surface elevation: 313.3m (AMSL). FFT elevation: 308.6m.
* BTEX analysis (EPA SW-846) by Maxxam Laboratories, Calgary, AB using GC/MS (MeOH Ext). EPA Method 8260C. HC Fractions by EPA Method 3510C.
** OWS and Naphtha analysis performed at Syncrude Research, Edmonton. Reported as wt.%.
1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

5.4 BML

Table 5-19 BML - General Chemistry of Water and FFT

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) [2]							
Sample Depth (m)		1	11	16	21	26	31	36	41	44
Sample Elevation (AMSL) (m)		307	297	292	287	282	277	272	267	264
General										
pH (units)		8.60	8.35	8.40	8.55	8.54	8.40	8.35	8.50	8.51
Conductivity (uS/cm)	1	2745	3920	3790	3740	4170	4025	3960	3800	3950
Temperature (°C)		14.8	7.2	12.4	14.7	15.8	16.3	15.9	15.3	14.8
Dissolved Solids (mg/L)**		1600	2300	2200	2300	2400	2300	2300	2400	2400
Total Solids Content (g/100g)		0.005	37.2	36.0	42.1	50.8	62.3	70.3	76.2	78.8
Alkalinity (Total as $CaCO_3$) (mg.L^{-1})	0.5	667	1296	1137	1100	1358	1220	1227	1231	1249
Chemical Oxygen Demand (mg.L^{-1})	5	170	220	270	250	220	240	240	260	-
Biological Oxygen demand (mg.L^{-1})	2	<2.0	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg.L^{-1})		-	-	-	-	-	-	-	-	-
Redox Potential (mV)		220	-	-	-	-	-	-	-	-
Phenols (ug.L^{-1})**	2	3.9	18	23	16	10	9.7	8.8	9	18
Tannin & Lignins (mg.L^{-1})**	0.4	0.94	1.41	1.77	1.51	1.36	1.39	1.26	-	-
Cyanide (ug.L^{-1})**	1	<2	<2	<2	<2	<2	<2	<2	<2	<2
MBAS (mg.L^{-1})**	0.1	-	0.37	0.5	0.39	0.22	0.49	0.5	-	-
Sulphides (mg.L^{-1})	0.002	0.002	0.005	0.022	0.015	0.009	0.013	0.013	0.010	-
Hydrogen Sulphide (mg.L^{-1})	0.002	0.002	0.005	0.023	0.016	0.009	0.014	0.014	0.01	-
Methane (ml/L)	0.8	-	-	-	-	-	-	-	-	-
Methyl Hg (ng/L)	0.02	0.14	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Mercury (Hg) (ug/L)	0.02	<0.002	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic (As) (ug/L)	0.20	2.61	7.01	18.2	9.79	12.9	10.6	11.8	6.77	8.26
Selenium (Se) (ug/L)	0.20	<0.50	<0.50	<0.50	0.55	<0.50	<0.50	<0.50	0.98	0.82
Total Pet. Hydrocarbon (TPH) (mg.L^{-1})	2	4	12540	4460	7797	12896	11580	9570	8460	8130
Bitumen Content (% by wt.)	0.01	<0.01	4.32	1.40	1.70	2.74	3.49	1.46	2.19	1.37
Naphtha Content (% by wt.)	0.01	<0.01	0.09	0.02	0.01	0.02	0.12	0.08	0.06	0.05
Total PAH's (mg/L)	0.001	0.002	304	97	134	211	231	197	149	137
Alkylated PAH's as % of Total PAH's		>99	98	98	98	98	98	98	98	98
Dis. Inorganic Carbon (DIC) (mgC.L^{-1})**	1	150	300	270	260	330	280	290	290	300
Dis. Organic Carbon (DOC) (mgC.L^{-1})**	2.5	32	40	44	39	41	44	45	47	51
Naphthenic Acids (mg.L^{-1})	5	40	62	83	92	75	71	59	77	84
Na/Cl Ratio (meq/meq)		2.30	2.37	2.22	2.22	2.46	2.27	2.23	2.19	2.20
Major Ion Ratio (ΣCat/ΣAn meq/meq)		1.02	0.99	1.00	1.01	0.99	0.99	0.99	0.99	0.98
Hardness (as mg/L $CaCO_3$)**		106	103	70	66	73	100	100	87	91
Acute Toxicity										
Rainbow Trout LC_{50} (% by vol)		>100	-	-	-	-	-	-	-	-
Rainbow Trout (% survival at 96 hrs.)		100	-	-	-	-	-	-	-	-
Daphnia Magna LC_{50} (% by vol)		>100	-	-	-	-	-	-	-	-
Daphnia Magna EC_{50} (immobility)		>100	-	-	-	-	-	-	-	-
Microtox IC_{50} (% by vol)		>82	-	-	-	-	-	-	-	-
Microtox IC_{20} (% by vol)		71	-	-	-	-	-	-	-	-
Nutrients										
o-Phosphate (ugP.L^{-1})	3	5.8	6.3	46	15	48	7.5	12	22	22
Total Phosphorous (ugP.L^{-1})	3	15	16	41	10	94	7.4	37	18	-
Ammonia (mgN.L^{-1})	0.015	0.45	12	17	15	7	12	13	13	14
Nitrite (ugN.L^{-1})	10	34	<10	<10	12	<10	<10	<10	<10	<10
Nitrate (ugN.L^{-1})	10	140	21	<10	27	<10	<10	25	18	17
Nitrate + Nitrite (ugN.L^{-1})	14	14	21	<14	39	<14	<14	25	18	17
Total Nitrogen (mgN.L^{-1})	0.05	0.86	13	16	19	7.4	14	12	13	14
Silicon (mg.L^{-1})	0.5	2.4	5.4	3.9	3.9	4.3	4.2	5.1	4.5	3.7
Major Ions (mg. L^{-1})										
Cations (mg. L^{-1})										
Sodium (Na^+)	2.5	610	915	900	905	990	925	910	950	940
Potassium (K^+)	0.3	8.3	14.0	12.0	14.0	12.0	14.0	16.0	17.0	17.0
Magnesium (Mg^{+2})	0.2	11.0	12.0	7.8	8.1	8.5	12.0	12.0	10.0	11.0
Calcium (Ca^{+2})	0.3	24	21	15	13	15	20	20	18	18
Total Cations (meq/L)		***29.1***	***42.6***	***41.2***	***41.4***	***45.1***	***43.0***	***42.4***	***43.9***	***43.6***
Anions (mg. L^{-1})										
Fluoride (F^-)	0.05	1.7	1.6	3.1	3.5	2.7	2.3	2.1	3.4	3.6
Chloride (Cl^-)	5	410	595	625	630	620	630	630	670	660
Bromide (Br^-)	0.003	0.25	0.32	0.36	0.36	0.32	0.33	0.33	0.36	0.34
Sulphate ($SO_4^=$)	1	180	22	41	51	40	69	37	44	45
Carbonate ($CO_3^=$)	1	24	52	55	50	65	56	45	55	51
Bicarbonate (HCO_3^-)	1	765	1475	1275	1240	1525	1375	1405	1390	1420
Total Anions (meq/L)		***28.6***	***43.1***	***41.2***	***40.8***	***45.5***	***43.6***	***43.1***	***44.4***	***44.5***

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308.2m (AMSL). FFT elevation: 298.4m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water (centrifuged and filtered).
**Dissolved Fraction: centrifuged at 30000g, then filtered (0.45u filter-passing). Naphthenic Acid (FTIR), bitumen, and solids (OWS), Naphtha analyses by Syncrude Research Lab.

Table 5-20 BML - Solids Fraction Profiles in FFT

	Fluid Fine Tailings (FFT)							
Sample Depth (m)	**11**	**16**	**21**	**26**	**31**	**36**	**41**	**44**
Sample Elevation (AMSL) (m)	**297**	**292**	**287**	**282**	**277**	**272**	**267**	**264**
Solids Content** (g/100g)	37.2	36.0	42.1	50.8	62.3	70.3	76.2	78.8
Fines Content -44*um / (-44um+w)*	37.2	36.0	41.4	47.9	51.5	55.6	52.0	55.0
Fines Content -*22um / (-22um+w)*	37.1	35.4	39.3	43.5	46.6	50.2	46.4	49.6
Fines Content -*11um / (-11um+w)*	33.6	31.8	33.7	36.1	39.4	43.1	39.5	42.9
Fines Content -*5.5um / (-5.5um+w)*	28.5	26.6	27.5	29.2	32.9	36.4	33.2	36.5
Fines Content -2.8*um / (-2.8um+w)*	21.2	19.8	20.3	21.8	25.1	28.3	25.9	28.8
SFR** (>44um / <44um)	0.00	0.00	0.04	0.13	0.56	0.93	1.88	2.08
Bitumen (g/100g)	4.32	1.40	1.70	2.74	3.49	1.46	2.19	1.37
Naphtha (g/100g)	0.09	0.02	0.01	0.02	0.12	0.08	0.06	0.05
Calc. Density (g/ml)	1.30	1.29	1.35	1.46	1.63	1.77	1.90	1.96
Size Fraction	**Particle Size Distribution*** (% solids less than)**							
1440um	100	100	100	100	100	100	100	100
900um	100	100	100	100	100	100	100	100
720um	100	100	100	100	100	100	100	100
500um	100	100	100	100	100	100	100	100
360um	100	100	100	100	100	100	100	100
250um	100	100	100	100	99	99	96	95
180um	100	100	100	100	93	88	76	72
125um	100	100	99	97	83	71	54	50
88um	100	100	98	95	75	62	44	41
62um	100	100	98	92	70	56	39	36
44um	100	100	97	88	64	52	35	32
31um	98	99	93	81	58	46	31	29
22um	97	98	88	74	53	42	28	26
16um	92	93	80	65	46	37	25	23
11um	83	83	69	54	39	31	21	20
7.8um	76	75	61	47	34	28	18	18
5.5um	66	64	52	40	30	24	16	15
3.9um	55	53	43	33	25	20	13	13
2.8um	44	44	35	27	20	16	11	11
1.9um	34	34	27	21	16	13	8.8	8.4
1.4um	26	27	21	16	12	10	7.0	6.7
1.0um	19	20	15	12	9.0	7.2	5.2	4.95
0.7um	12	13	9.8	7.4	5.7	4.6	3.50	3.34
0.5um	6.4	7.4	5.6	4.3	3.3	2.6	2.20	2.12
0.35um	2.7	3.3	2.5	2.0	1.5	1.2	1.19	1.18
0.25um	0.85	1.16	0.85	0.7	0.6	0.5	0.57	0.59
0.18um	0.16	0.27	0.19	0.19	0.14	0.12	0.24	0.27
0.13um	0.01	0.03	0.02	0.02	0.02	0.01	0.08	0.10
0.10um	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04
Mean Particle Size (um)	***3.2***	***3.1***	***4.8***	***7.7***	***16.4***	***25.4***	***46.9***	***51.3***

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308m (AMSL). FFT elevation: 298.4m.

**SFR: Sand (solids>44um) to Fines (solids <44um) ratio.

***PSD determined using Coulter Laser Diffraction method at Syncrude's Research Dept.

Table 5-21 BML - Elemental Content of Water and FFT Pore Water

	DL	Surface Water [1]	Fluid Fine Tailings (FFT) Pore Water [2]							
Sample Depth (m)		**1**	**11**	**16**	**21**	**26**	**31**	**36**	**41**	**44**
Sample Elevation (AMSL) (m)		**307**	**297**	**292**	**287**	**282**	**277**	**272**	**267**	**264**
Conductivity (uS/cm)		2800	4000	3900	3950	4200	4100	4100	4300	4150
Solids Content (wt.%)		0.01	37.2	36.0	42.1	50.8	62.3	70.3	76.2	78.8
Bitumen Content (wt.%)		<0.01	4.3	1.4	1.7	2.7	3.5	1.5	2.2	1.4
Dissolved Major Elements (mg.L^{-1})**										
Sodium (Na)	***2.5***	580	830	810	810	910	840	840	880	880
Potassium (K)	***0.3***	8.3	14	12	14	12	14	16	17	17
Magnesium (Mg)	***0.2***	11	12	7.8	8.1	8.5	12	12	10	11
Calcium (Ca)	***0.3***	24	21	15	13	15	20	20	18	18
Silicon (Si)	***0.5***	2.36	5.4	3.9	3.9	4.3	4.2	5.1	4.5	3.7
Strontium (Sr)	***0.005***	0.56	0.84	0.60	0.58	0.66	0.86	0.87	0.78	0.81
Sulphur (S)	***15***	59	<15	<15	17.7	<15	23.7	<15	16.6	<15
Dissolved Trace Elements (ug.L^{-1})**										
Aluminum (Al)	***15***	<15	38	<15	<15	<15	<15	72	23	<15
Antimony (Sb)	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Arsenic (As)	***0.5***	2.61	7.01	18.2	9.79	12.9	10.6	11.8	6.77	8.26
Barium (Ba)	***5***	261	603	440	371	459	474	573	532	565
Beryllium (Be)	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Boron (B)	***250***	1840	3380	3050	3300	3030	2770	3100	3060	2920
Cadmium (Cd)	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt (Co)	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper (Cu)	***1***	<1.0	3.3	5	1.7	3.1	4.5	3.7	2.1	<1.0
Iron (Fe)	***60***	<60	<60	<60	<60	<60	<60	<60	<60	<60
Lead (Pb)	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lithium (Li)	***10***	133	234	221	227	234	241	272	254	260
Manganese (Mn)	***4***	<4	44	22	10	26	32	38	33	28
Mercury (Hg)	***0.002***	<0.002	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum (Mo)	***5***	23.6	19.3	18.7	28.3	33	43.6	49.9	108	148
Nickel (Ni)	***5***	5.3	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.9	<5.0
Phosphorus (P)	***50***	<50	<50	<50	<50	101	<50	<50	<50	<50
Selenium (Se)	***0.5***	<0.50	<0.50	<0.50	0.55	<0.50	<0.50	<0.50	0.98	0.82
Silicon (Si)	***500***	2360	5440	3930	3860	4260	4200	5050	4450	3730
Silver (Ag)	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Strontium (Sr)	***5***	555	842	597	575	662	855	867	779	805
Thallium (Tl)	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Thorium (Th)	***5***	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Tin (Sn)	***25***	<25	<25	<25	<25	<25	<25	<25	<25	<25
Titanium (Ti)	***25***	<25	<25	<25	<25	<25	<25	<25	<25	<25
Tungsten (W)	***2***	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	***0.5***	2.79	1.67	2.52	2.54	2.37	2.4	3.35	9.47	14.9
Vanadium (V)	***25***	<25	<25	<25	<25	<25	<25	<25	<25	28
Zinc (Zn)	***25***	<25	27	<25	<25	<25	26	<25	<25	<25
Zirconium (Zr)	***0.5***	2.7	4.7	3.6	3.6	4.8	4.7	5.8	7.7	8.6

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308m (AMSL). FFT elevation: 298.4m.
1) Free Water Zone above FFT interface (0.45u filter-passing).
2) Fine Tails Pore Water centrifuged at 30000g, then filtered (0.45u filter-passing).
**Dissolved: 0.45u filter-passing. Analyzed using ICP/MS (except Hg by Cold Vapour AA) by Maxxam Analytical. Major Elements expressed in mg/L, Minor Elements expressed in ug/L.

Table 5-22 BML - PAH Concentrations in Water and FFT

	Polycyclic Aromatic Hydrocarbons (PAH) Concentrations												
	Mol wt	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]									
Sample Depth (m)		*DL (ug/L)*	1	*DL (mg/kg)*	11	11	16	21	26	31	36	41	44
Sample Elevation (AMSL) (m)			**307**		**297**	**297**	**292**	**287**	**282**	**277**	**272**	**267**	**264**
Solids Content** (wt%)			0.03		37.2	37.2	36.0	42.1	50.8	62.3	70.3	76.2	78.8
Hydrocarbon** (wt%)			<0.01		4.32	4.32	1.40	1.70	2.74	3.49	1.46	2.19	1.37
Naphtha** (wt%)			<0.01		0.09	0.09	0.02	0.01	0.02	0.12	0.08	0.06	0.05
Polycyclic Aromatic Hydrocarbons													
Total Parent PAH's			<0.1		6.6	5.2	1.7	2.1	3.4	5.0	4.5	3.0	2.8
Total Alkylated PAH's			1.9		298	235	95	132	207	226	192	146	134
Alkylated PAH's as % of Total PAH's			>99		98	98	98	98	98	98	98	98	98
PAH Compounds													
Quinoline	129	***0.2***	<0.20	***0.1***	0.29	0.23	0.12	0.14	0.17	0.21	0.14	0.14	0.14
Naphthalene	128	***0.1***	<0.10	***0.05***	0.21	0.18	<0.05	<0.05	<0.05	0.10	0.12	0.06	0.05
2-Methylnaphthalene	142	***0.1***	<0.10	***0.05***	0.16	0.13	<0.05	<0.05	<0.05	0.06	0.09	<0.05	<0.05
C1-Naphthalene	142	***0.1***	<0.10	***0.05***	0.30	0.27	0.07	<0.05	0.05	0.15	0.12	0.13	0.10
C2-Naphthalene	156	***0.1***	<0.10	***0.05***	0.83	0.67	0.19	0.14	0.18	0.41	0.44	0.31	0.22
C3-Naphthalene	170	***0.1***	<0.10	***0.05***	4.9	3.9	1.3	2	2.6	4	3.6	2.2	2
C4-Naphthalene	184	***0.1***	0.14	***0.05***	14	11	4.4	5.8	8.8	11	9.3	6.7	6
Acenaphthylene	152	***0.1***	<0.10	***0.05***	0.055	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
Acenaphthene	154	***0.1***	<0.10	***0.05***	0.59	0.49	0.14	0.19	0.27	0.38	0.3	0.2	0.22
Fluorene	166	***0.05***	<0.05	***0.05***	0.25	0.20	0.07	0.09	0.13	0.21	0.18	0.12	0.10
C1-fluorene	180	***0.05***	<0.05	***0.05***	2.3	1.8	0.66	0.93	1.4	1.7	1.4	0.99	0.85
C2-fluorene	194	***0.05***	0.066	***0.05***	6.8	4.9	1.9	2.5	3.9	4.9	4	2.9	3
C3-fluorene	208	***0.05***	<0.05	***0.05***	17	12	5.2	7.6	12	11	9.9	7.9	7
Biphenyl	154	***0.02***	<0.02	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05
C1-biphenyl	168	***0.02***	<0.02	***0.05***	0.14	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C2-biphenyl	182	***0.02***	<0.02	***0.05***	0.91	0.69	0.26	0.35	0.51	0.71	0.45	0.36	0.35
Phenanthrene	178	***0.05***	<0.05	***0.05***	1.7	1.4	0.38	<0.05	0.31	1.3	1.2	0.81	0.73
C1-phenanthrene/anthracene	192	***0.05***	<0.05	***0.05***	8.5	6.9	1.8	1.5	3	7.1	6.1	4	3.6
C2-phenanthrene/anthracene	206	***0.05***	0.091	***0.05***	16	13	4.4	5.7	9.2	13	11	8	7.3
C3-phenanthrene/anthracene	220	***0.05***	0.21	***0.05***	32	27	11	15	23	26	20	17	15
C4-phenanthrene/anthracene	234	***0.05***	0.13	***0.05***	13	11	4.5	6.5	10	10	9.2	6.6	6.3
Anthracene	178	***0.01***	<0.01	***0.04***	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Acridine	*179*	***0.2***	<0.05	***0.1***	0.87	0.74	0.26	0.35	0.56	0.72	0.61	0.43	0.37
Dibenzothiophene	184	***0.02***	<0.02	***0.05***	0.26	0.19	0.12	0.21	0.25	0.21	0.19	0.09	0.09
C1-dibenzothiophene	198	***0.02***	<0.02	***0.05***	8.8	6.5	3	3.5	5	6.7	5.4	4	3.9
C2-dibenzothiophene	212	***0.02***	0.24	***0.05***	39	29	11	15	23	28	23	17	15
C3-dibenzothiophene	226	***0.02***	0.24	***0.05***	35	26	11	14	26	25	21	16	15
C4-dibenzothiophene	240	***0.02***	0.13	***0.05***	27	19	7.8	11	18	18	16	12	11
Fluoranthene	202	***0.01***	<0.01	***0.05***	0.24	0.19	0.08	0.11	0.17	0.19	0.15	0.10	0.10
Pyrene	202	***0.02***	<0.02	***0.05***	0.75	0.6	0.24	0.34	0.5	0.58	0.46	0.34	0.31
C1-fluoranthene/pyrene	216	***0.02***	0.04	***0.05***	3.1	2.5	1	1.4	2.3	2.4	2	1.5	1.4
C2-fluoranthene/pyrene	230	***0.02***	0.1	***0.05***	9	7.7	3.2	4.8	7.4	7.3	6.3	4.8	4.5
C3-fluoranthene/pyrene	244	***0.02***	0.26	***0.05***	25	21	9	14	21	20	18	14	13
C4-fluoranthene/pyrene	258	***0.02***	0.15	***0.05***	14	13	5.6	8.6	13	12	11	8.3	8.2
Benzo(a)anthracene	228	***0.009***	<0.009	***0.05***	0.11	0.10	<0.05	0.05	0.08	0.10	0.10	0.07	0.07
Chrysene	228	***0.009***	<0.009	***0.05***	0.17	0.11	0.07	0.11	0.12	0.15	0.15	0.10	0.08
C1-benzo(a)anthracene/chrysene	242	***0.009***	0.049	***0.05***	2.6	2.2	0.96	1.4	2	2.1	1.8	1.4	1.3
C2-benzo(a)anthracene/chrysene	256	***0.009***	0.075	***0.05***	8.8	7.7	3.4	5	7.4	7.3	6	4.9	4.7
C3-benzo(a)anthracene/chrysene	270	***0.009***	<0.009	***0.05***	4.8	4.0	1.8	2.7	4.0	3.9	3.5	2.6	2.4
C4-benzo(a)anthracene/chrysene	284	***0.009***	<0.009	***0.05***	1.20	1.00	0.48	0.71	1.10	1.10	0.96	0.75	0.68
Benzo[e]pyrene	252	***0.05***	<0.05	***0.05***	0.25	0.22	0.10	0.13	0.20	0.20	0.18	0.13	0.13
Benzo(b&j)fluoranthene	252	***0.009***	<0.009	***0.05***	0.19	0.16	0.07	0.10	0.14	0.15	0.13	0.09	0.09
Benzo(k)fluoranthene	252	***0.009***	<0.009	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C1-benzo(bjk)fluoranthene/benzo(a)pyrene	266	***0.008***	<0.008	***0.05***	1.40	1.30	0.63	0.87	1.30	1.30	0.94	0.96	0.94
C2-benzo(bjk)fluoranthene/benzo(a)pyrene	280	***0.008***	<0.008	***0.05***	1.40	1.20	0.58	0.85	1.30	1.20	1.00	0.87	0.73
Benzo(c)phenanthrene	252	***0.05***	<0.05	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene	252	***0.008***	<0.008	***0.05***	0.13	0.12	<0.05	0.06	0.09	0.08	0.08	0.06	0.05
Benzo[a]pyrene (equival.)	252	***0.01***	<0.01	***0.07***	0.19	0.02	<0.07	0.10	0.14	0.14	0.13	0.11	0.10
Dibenz(a,h)anthracene	278	***0.008***	<0.008	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Perylene	252	***0.05***	<0.05	***0.05***	0.20	0.16	0.07	0.10	0.15	0.16	0.13	0.11	0.09
Benzo(g,h,i)perylene	276	***0.009***	<0.009	***0.05***	0.10	0.10	<0.05	0.06	0.08	0.08	0.07	0.06	0.05
Indeno(1,2,3-cd)pyrene	276	***0.10***	<0.009	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,e)pyrene	302	***0.10***	<0.2	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)pyrene	302	***0.10***	<0.2	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,i)pyrene	302	***0.10***	<0.2	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,l)pyrene	302	***0.10***	<0.2	***0.10***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308.2m (AMSL). FFT elevation: 298.4m.
GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole surface water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-23 BML - VOC Concentrations in Water and FFT

	Volatile Organic Compound (VOC) Concentrations											
	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]									
Sample Depth (m)	***DL (ug/L)***	**1**	***DL (mg/kg)***	**11**	**11**	**16**	**21**	**26**	**31**	**36**	**41**	**44**
Sample Elevation (AMSL) (m)		**307**		**297**	**297**	**292**	**287**	**282**	**277**	**272**	**267**	**264**
F1 Hydrocarbons (C6-C10)	***100***	<100	***10***	840	730	160	57	96	780	470	460	360
F2 Hydrocarbons (C10-C16)	***100***	830	***10***	1800	1400	610	940	1400	1400	1200	1000	970
Volatile Organic Compounds												
1,1,1,2-tetrachloroethane	***0.5***	<0.50	***0.1***	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,1-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1,2,2-tetrachloroethane	***2***	<2.0	***0.6***	<0.60	<0.70	<0.40	<0.15	<0.40	<0.75	<1.0	<1.0	<1.0
1,1,2-trichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,2,3-trichloropropane	***0.3***	<0.30	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-dibromoethane	***0.2***	<0.20	***0.002***	0.012	0.012	0.006	0.002	0.003	0.019	0.006	<0.002	0.004
1,2-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,2-dichloroethane	***0.5***	<0.50	***0.002***	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
1,2-dichloropropane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,3-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,4-dichlorobenzene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2-Butanone (MEK)	***70***	<70	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
2-Hexanone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
4-Methyl-2-pentanone (MIBK)	***25***	<25	***1.3***	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Acetone	***50***	<50	***2.5***	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Acrolein	***10***	<10	***10***	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acrylonitrile	***10***	<10	***0.5***	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromoform	***0.5***	<0.50	***0.05***	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromomethane	***2***	<2.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Carbon disulfide	***1***	<1.0	***0.2***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Carbon tetrachloride	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	***0.5***	<0.50	***0.001***	0.006	0.008	0.003	0.003	0.004	0.012	0.023	0.022	0.020
Chlorodibromomethane	***1***	<1.0	***0.03***	<0.03	<0.04	<0.02	<0.02	<0.02	<0.06	<0.06	<0.10	<0.07
Chloroethane	***1***	<1.0	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroform	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
cis-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
cis-1,3-dichloropropene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibromomethane	***0.5***	<0.50	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dichlorodifluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dichloromethane	***2***	<2.0	***0.03***	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ethanol	***1***	<1.0	***1***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl methacrylate	***5***	<5.0	***0.25***	13.0	12.0	3.4	0.7	1.4	11.0	9.2	8.2	7.6
Iodomethane	***4***	<4.0	***-***	-	-	-	-	-	-	-	-	-
Styrene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Tetrachloroethene	***0.5***	<0.50	***0.02***	0.036	0.040	<0.02	<0.02	<0.02	0.038	<0.02	<0.02	<0.02
Total Trihalomethanes	***1.3***	<1.3	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
trans-1,2-dichloroethene	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
trans-1,3-dichloropropene	***0.5***	<0.50	***0.02***	0.037	0.036	<0.02	<0.02	<0.02	0.032	0.025	0.024	<0.02
Trichloroethene	***0.5***	<0.50	***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorofluoromethane	***0.5***	<0.50	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Vinyl chloride	***0.5***	<0.50	***0.001***	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308.2m (AMSL). FFT elevation: 298.4m.
VOCs as defined in modified headspace US EPA Protocol (Method 8260C). GC/MS analyses performed by Maxxam Analytics, Calgary, AB.
1) Surface Zone: Concentrations reported as ug per L of whole water sample.
2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

Table 5-24 BML - BTEX Compounds and Hydrocarbon Fractions in Water and FFT

	Surface Water (ug/L)[1]		Fluid Fine Tailings (FFT) (mg/kg)[2]									
Sample Depth (m)	***DL (ug/L)***	**1**	***DL (mg/kg)***	**11**	**11**	**16**	**21**	**26**	**31**	**36**	**41**	**44**
Sample Elevation (AMSL) (m)		**308**		**297**	**297**	**292**	**287**	**282**	**277**	**272**	**267**	**264**
Volatile Organic Compounds (VOC's): BTEX Compounds *												
Benzene	***0.4***	<0.40	***0.005***	0.46	0.59	0.01	<0.005	<0.005	0.03	0.03	0.02	0.02
Ethylbenzene	***0.4***	<0.40	***0.01***	0.07	0.09	0.01	0.01	0.01	0.06	0.03	0.03	0.02
Toluene	***0.4***	<0.40	***0.02***	0.03	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
o-Xylene	***0.4***	<0.40	***0.02***	<0.02	<0.02	<0.02	<0.02	<0.02	0.024	<0.02	<0.02	<0.02
m & p-Xylene	***0.8***	<0.80	***0.04***	0.58	0.61	0.06	<0.04	<0.04	0.24	0.11	0.13	0.10
Xylenes (Total)	***0.9***	<0.9	***0.05***	0.58	0.60	0.06	<0.05	<0.05	0.27	0.11	0.13	0.10
Hydrocarbon Fractions												
F1 (C6-C10)	***100***	<100	***10***	840	730	160	57	96	780	470	460	360
F2 (C10-C16)	***100***	830	***10***	1800	1400	610	940	1400	1400	1200	1000	970
F3 (C16-C34)	***100***	3200	***50***	7300	5700	2700	4800	7900	6600	5500	4900	4700
F4 (C34-C50)	***200***	<200	***50***	2600	2100	990	2000	3500	2800	2400	2100	2100
Solids and Hydrocarbon Content **												
Solids (g/100g)		<0.02		37.2	37.2	36.0	42.1	50.8	62.3	70.3	76.2	78.8
Bitumen (g/100g)		<0.01		4.32	4.32	1.40	1.70	2.74	3.49	1.46	2.19	1.37
Naphtha (g/100g)		<0.01		0.09	0.09	0.02	0.01	0.02	0.12	0.08	0.06	0.05

Sample Date: May 30, 2018. Coordinates (UTM): 6318994N, 463003E. Surface elevation: 308.2m (AMSL). FFT elevation: 298.4m.

* BTEX analysis (EPA SW-846) by Maxxam Laboratories, Calgary, AB using GC/MS (MeOH Ext) EPA Method 8260C. HC Fractions by EPA Method 3510C.

** OWS and Naphtha analysis performed at Syncrude Research, Edmonton. Reported as wt %.

1) Surface Zone: Concentrations reported as ug per L of whole water sample.

2) FFT Zone: Concentrations reported as mg per kg of whole FFT sample.

5.5 NMSP

Table 5-25 NMSP Water Chemistry

Sample ID:	NMSPE
Sample Date:	7-Nov-18
Sample Time:	9:50

Parameter	Unit	Results
Aluminum	mg/L	4.77
Boron	mg/L	2.46
Barium	mg/L	0.28
Calcium	mg/L	10.2
Cadmium	mg/L	<0.008
Cobalt	mg/L	<0.01
Chromium	mg/L	<0.01
Copper	mg/L	<0.03
Iron	mg/L	0.91
Potassium	mg/L	16.7
Magnesium	mg/L	7.9
Manganese	mg/L	0.038
Molybdenum	mg/L	0.12
Sodium	mg/L	953
Nickel	mg/L	<0.02
Phosphates	mg/L	<0.4
Lead	mg/L	<0.2
Silica	mg/L	20.9
Tin	mg/L	<0.03
Titanium	mg/L	0.19
Vanadium	mg/L	0.03
Zinc	mg/L	<0.01
Zirconium	mg/L	0.02
Carbonate	mg/L	7.3
Bicarbonate	mg/L	741
pH	-	8.25
Conductivity (µS/cm)	µS/cm	4000
Chloride	mg/L	574
Sulfate	mg/L	578
Ammonium	mg/L	14
TSS	mg/L	376
Hardness	mg/L	58
Cations/Anions	-	1.1

6 Surface Water Management

Development of mining areas requires the establishment of drainage systems to manage surface water. The drainage system components are designed to maximize interception of clean surface and aquifer water for return to the environment as well as minimize impact to surface water quantity and quality.

Surface water within the site is primarily managed through two major ditch networks. Water that has come into contact with the plant and mine areas, as well as water that has been collected via tailings seepage control systems is managed through the recycle water ditch network which is part of the industrial wastewater system; whereas, non-process affected water is managed through the clean water ditch network. These networks are managed separately to ensure that process affected water is retained on site for use within the plant and non-process affected water is returned back to the environment as much as possible.

An overview of the recycle water and clean water ditch networks is shown in Figure 6-1. This figure does not include the numerous recycle water ditches and sumps within the active mine footprint because they are frequently moved to support mining activities. Also not shown on the figure are the major ditch networks that are under construction or in the design and planning stages.

6.1 Tailings Seepage Control System

Seepage from above ground tailings dykes is managed as part of the recycle water system. The water is controlled by a series of sand drains and collection pipes. Ditches at the toe of the structure collect the seepage water which is then returned back to the tailings facility to become part of the recycle water inventory. Cut-off walls have been installed where required around tailings facilities to control seepage.

6.2 Recycle Water System

The recycle water ditch network is a series of closed-circuit ditches that collect and convey recycle water within the site via ditches, sumps and pipelines. The recycle water discharge locations include the various tailings facilities and the plant Recycle Water (RCW) Pond. The following is a summary of the surface drainage directions for the recycle water ditch network:

- Drainage around the west side of the Southwest Sand Storage facility (SWSS) is directed north in to North Mine South Pond (NMSP) or to the mine recycle water ditching system, which will discharge into the RCW pond.
- Drainage around the north, east and south sides of SWSS, the Special Waste Interment Storage Area (SWISA) and the Flue Gas Desulphurization (FGD) landfill is directed into Southwest In-Pit (SWIP).
- Drainage around the south and north of South Hills and Beaver Creek sump is directed into SWIP via pipeline.

- Drainage around Coke Cell 5 is directed into SWIP via pipeline while drainage around the top of Coke Cell 5 is directed into BML via a drainage channel.
- Drainage around MLSB is directed into the Seepage Control Pond in the northeast or the Recycle Water Pond in the south.
- Drainage around EIP is directed back into EIP and eventually into SWIP via pipeline.
- Drainage around the sulphur blocks is diverted into the recycle water ditch, which flows into the Recycle Water Pond.
- Drainage within active mine pits is collected by a temporary system of sumps, pumps and ditches that route the water to the primary recycle water ditch network.

6.3 Clean Water System

The clean water ditch network is a series of ditches that intercepts non-process affected environmental surface water runoff and flow from entering the site. The water is collected via ditches located outside the active mine footprint and is diverted back to the environment. The final discharge locations for the clean water ditches are Bridge Creek and the Beaver Creek Reservoir. The following are the surface drainage directions for the clean water ditch network:

- Clean water from the Southwest Clean Water Interceptor Ditch is directed into the Beaver Creek Reservoir.
- Clean water from the north and west side of MLSB is directed into the West Interceptor Ditch, which is discharged into Bridge Creek.

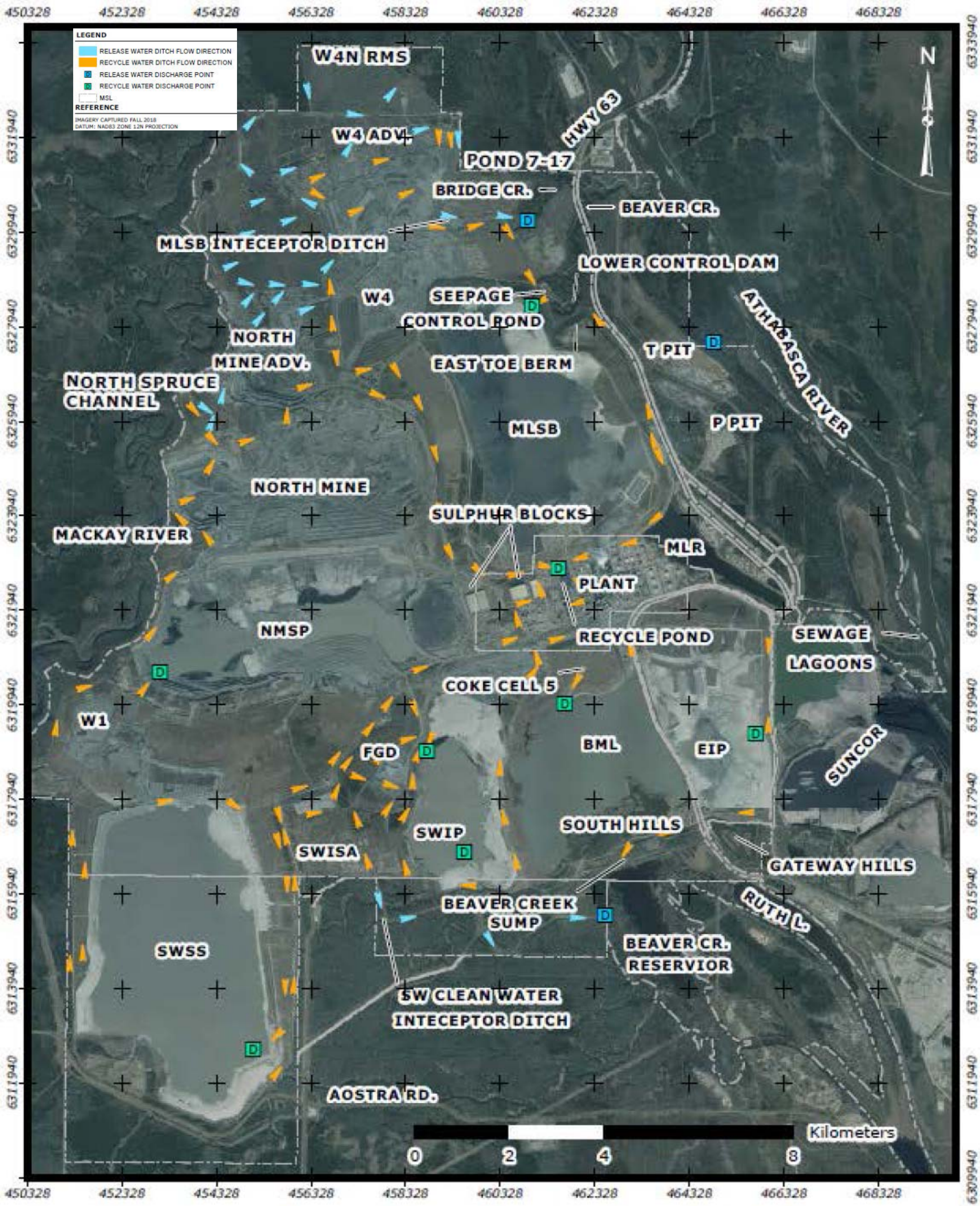

Figure 6-1 Overview of Recycle Water and Clean Water Networks

7 Groundwater Monitoring

7.1 Groundwater Monitoring Program

The focus of the groundwater monitoring program is to examine the groundwater across the site to identify whether any industrial impacts are occurring and to implement remedial actions if necessary. Annual sampling is done to monitor for potential physical changes (water level) and chemical changes (water chemistry).

An overview of the groundwater observation wells and their corresponding sample results are shown on the following pages. Only monitoring data related to tailings areas is included in this report.

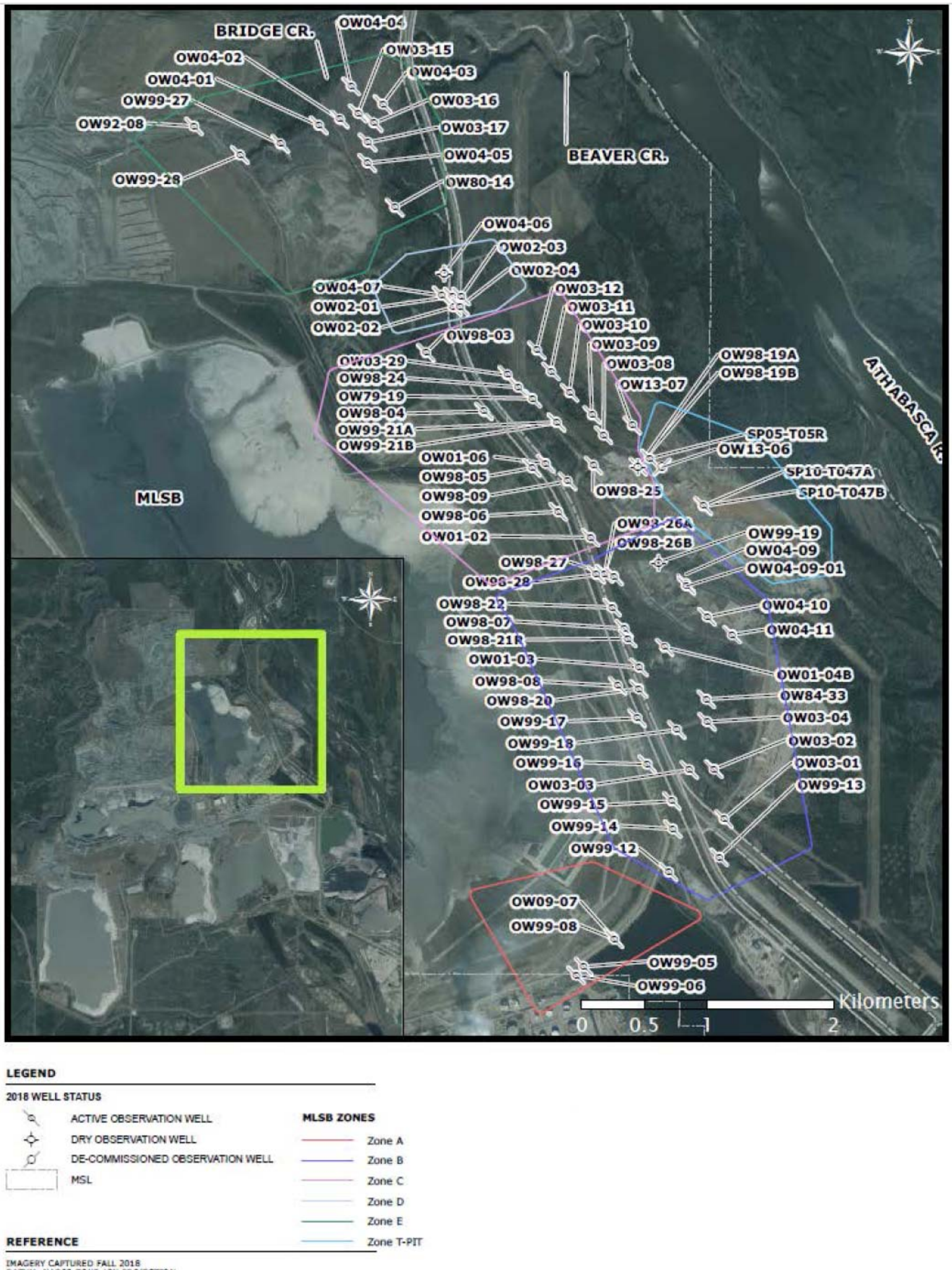

Figure 7-1 Groundwater Observation Well Locations – East MLSB Area

Table 7-1 Groundwater Observation Sample Results – East MLSB Zone A

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: South and East of MLSB: Zone A																							
OW99-05	PF4	06-Jul-18	7.67	2500	470	12	42	210	140	< 1.0	1000	850	150	38	34	0.98	1300	100	170	3.45	0.19	6.63	7.01
OW99-06	PF4	06-Jul-18	8.11	2200	440	5.8	22	200	27	18	1100	920	77	49	55	1	1300	57	81	3.40	0.08	12.14	34.01
OW09-07	BFIL	06-Jul-18	7.89	2300	470	23	58	180	110	3.5	1000	860	240	35	37	2.4	1300	280	220	4.03	0.29	4.27	8.92
OW99-08	BFIL	05-Jul-18	7.74	2100	420	22	49	170	84	< 1.0	990	810	210	35	38	2.2	1100	210	310	3.81	0.26	4.29	10.43

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Table 7-2 Groundwater Observation Sample Results – East MLSB Zone B

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
AREA: East of MLSB Zone B																							
OW84-33	unknown	11 Jul 2018	6.99	740	15	26	110	49	53	< 1.0	320	260	380	3.8	< 1.0	0.039	34	120	110	0.47	1.45	0.09	0.59
OW98-07	PF4/PL2	09 Jul 2018	6.74	160	7.6	3.1	16	18	34	< 1.0	13	11	52	17	< 1.0	0.027	< 20	44	22	0.65	4.28	0.31	0.47
OW98-08	PF4	10 Jul 2018	7.6	2500	550	15	52	230	100	< 1.0	1100	920	190	42	43	1.1	1000	110	250	3.69	0.21	6.24	11.48
OW98-20	PF4	10 Jul 2018	7.05	1300	82	41	150	71	190	< 1.0	500	410	530	18	< 1.6	0.056	430	420	150	1.78	1.32	0.33	0.90
OW98-21R	PF4	09 Jul 2018	6.69	1700	56	60	250	120	470	< 1.0	400	330	870	< 0.50	< 1.0	0.034	55	440	110	0.72	2.64	0.14	0.25
OW98-22	PF4	09 Jul 2018	7.81	310	8.7	10	35	29	44	< 1.0	75	61	130	< 0.50	< 1.0	0.05	< 20	67	43	0.46	2.03	0.15	0.41
OW98-26A	PF4	09 Jul 2018	7.11	1700	56	60	250	130	470	< 1.0	400	330	870	10	< 1.0	0.28	53	440	110	0.66	2.64	0.14	0.25
OW98-26B	PG1	09 Jul 2018	7.6	690	150	4.1	16	25	< 1.0	1.2	400	330	56	5.7	1.9	0.32	1000	120	99	9.26	0.17	5.74	313.04
OW98-27	PF4	09 Jul 2018	7.33	1600	210	23	97	150	160	< 1.0	570	460	340	17	7	0.067	400	240	240	2.16	0.72	1.36	2.74
OW98-28	PF4	09 Jul 2018	7.02	2900	260	56	210	700	82	< 1.0	380	310	770	11	< 1.0	0.071	36	320	350	0.57	2.41	0.75	6.62
OW99-12	PF5B	07 Jul 2018	7.14	1300	84	27	150	120	140	< 1.0	470	380	470	8.8	< 1.0	0.13	37	190	180	1.08	1.26	0.38	1.25
OW99-13	PF4	09 Jul 2018	7.03	2900	260	57	220	730	81	< 1.0	380	310	780	5.9	< 1.0	0.063	31	320	350	0.55	2.50	0.72	6.70
OW99-14	PF4	11 Jul 2018	6.56	2100	180	51	200	260	360	< 1.0	460	380	700	13	< 1.0	< 0.015	26	310	210	1.07	1.87	0.55	1.04
OW99-15	PF5A	10 Jul 2018	6.8	1700	240	28	120	160	90	< 1.0	710	590	420	21	4.1	0.32	190	160	440	2.32	0.71	1.26	5.57
OW99-16	PF5A	10 Jul 2018	7.44	2100	410	24	78	180	190	< 1.0	840	690	290	30	19	0.7	1200	180	700	3.52	0.43	3.04	4.50
OW99-17	PF4	10 Jul 2018	7.49	2900	600	26	68	260	280	< 1.0	1000	860	280	39	44	1.2	1900	120	180	3.56	0.34	4.72	4.47
OW99-18	PF4	11 Jul 2018	6.94	1400	150	19	130	200	150	< 1.0	310	260	410	4.1	< 1.0	< 0.015	60	210	140	1.16	1.58	0.81	2.09
OW01-03	PF4	09 Jul 2018	6.88	1300	120	23	94	210	91	< 1.0	240	200	330	7.3	< 1.0	< 0.015	110	350	210	0.88	1.66	0.79	2.75
OW01-04B	PF5B/PF4	11 Jul 2018	7.28	650	9.4	20	100	26	69	< 1.0	290	240	340	2.1	< 1.0	< 0.015	24	130	160	0.56	1.39	0.06	0.28
OW03-01	PF4	11 Jul 2018	6.15	1300	26	45	210	42	420	< 1.0	280	230	700	10	< 1.0	0.1	< 20	300	210	0.96	3.07	0.08	0.13
OW03-02	PF4/PF5A	11 Jul 2018	6.71	660	10	21	110	4.4	120	< 1.0	270	220	360	4.8	< 1.0	0.017	21	170	71	3.51	1.62	0.06	0.17
OW03-03	PF4	11 Jul 2018	6.58	1300	140	21	120	160	53	< 1.0	500	410	380	10	< 1.7	0.053	< 20	140	190	1.35	0.94	0.79	5.51
OW03-04	PF4/PF5A	11 Jul 2018	6.9	810	34	23	110	69	71	< 1.0	300	250	360	5.6	< 1.0	0.088	42	150	270	0.76	1.49	0.20	1.00
OW04-09	PG1	11 Jul 2018	7.1	2900	11	170	580	5.2	1800	< 1.0	350	290	2100	16	< 1.0	0.11	47	630	24	3.27	7.44	0.01	0.01
OW04-09-01	PG3/PGKC	13 Oct 2018	6.05	910	160	8.5	21	2.7	2.8	< 1.0	600	500	88	7.2	2.7	1.5	2500	490	180	91.47	0.18	3.98	119.25
OW04-10	PF4	11 Jul 2018	6.64	1400	11	51	260	13	600	< 1.0	240	200	860	8.8	< 1.0	0.44	48	310	230	1.31	4.33	0.03	0.04
OW04-11	PF4	11 Jul 2018	6.78	860	9.1	31	140	18	220	< 1.0	260	210	480	6.8	< 1.0	0.49	37	160	150	0.78	2.22	0.04	0.09

Syncrude

Table 7-3 Groundwater Observation Sample Results – East MLSB Zone C

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: Zone C – East of MLSB and East Toe-Berm																							
OW79-19	PF	09 Jul 2018	7.48	1200	80	24	120	190	62	< 1.0	280	230	390	2.7	< 1.0	0.052	50	180	290	0.65	1.72	0.44	2.69
OW98-03	PF	27 Jun 2018	7.34	700	3.8	28	110	8.7	110	< 1.0	320	260	400	15	< 1.0	0.034	< 20	110	99	0.67	1.48	0.02	0.07
OW98-04	PF4/98	29 Jun 2018	7.5	740	22	28	100	22	170	< 1.0	240	200	380	4.9	< 1.1	0.025	79	250	76	1.54	1.84	0.13	0.27
OW98-05	PF4	29 Jun 2018	7.54	2500	510	15	47	270	150	7.2	890	740	180	35	18	0.2	1400	150	100	2.92	0.24	6.19	7.10
OW98-06	PF4/PG1	29 Jun 2018	7.6	2900	570	19	55	310	190	3.3	1000	840	210	40	28	0.71	1300	190	130	2.84	0.26	5.75	6.26
OW98-09	PF4	10 Jul 2018	7.44	2800	580	18	60	310	190	< 1.0	1000	850	220	32	28	0.57	1500	170	170	2.89	0.27	5.63	6.37
OW98-19A	PF4/PL2	11 Jul 2018	7.04	1100	120	20	88	47	350	< 1.0	97	79	300	7.3	< 2.1	0.049	< 20	120	130	3.94	3.72	0.86	0.72
OW98-24	PF4	14 Jul 2018	6.63	720	14	20	98	60	52	< 1.0	210	170	330	4.8	< 1.0	< 0.015	49	160	190	0.36	1.88	0.09	0.56
OW98-25	PF4	10 Jul 2018	6.8	2200	410	20	90	240	140	< 1.0	780	640	310	16	2.2	0.04	790	160	250	2.64	0.48	2.90	6.11
OW99-21A	PF4	10 Jul 2018	7.08	2400	460	8.6	46	260	150	< 1.0	860	700	150	31	5.7	0.039	1000	72	81	2.73	0.21	6.66	6.40
OW99-21B	PF4	10 Jul 2018	6.82	1300	160	20	88	160	110	< 1.0	440	360	300	12	< 1.0	0.024	310	180	140	1.54	0.83	1.15	3.04
OW01-02	PF4	14 Jul 2018	6.98	1400	150	25	100	260	56	< 1.0	320	260	350	10	< 1.0	1.6	59	190	140	0.89	1.34	0.93	5.59
OW01-06	PF4	10 Jul 2018	7.52	2600	560	14	39	300	170	< 1.0	920	760	160	33	29	0.71	1600	140	130	2.88	0.20	7.86	6.87
OW03-08	PF4	10 Jul 2018	6.99	2000	340	18	87	230	130	< 1.0	720	590	290	16	2.2	0.034	810	160	390	2.28	0.49	2.54	5.46
OW03-09	PF4	10 Jul 2018	6.19	2300	14	87	460	4.6	1300	< 1.0	360	300	1500	7.4	< 1.0	0.67	85	930	47	4.70	5.08	0.02	0.02
OW03-10	PF4	10 Jul 2018	6.05	1300	8	31	230	7.1	450	< 1.0	330	270	710	6	< 1.0	0.25	68	300	140	1.74	2.58	0.02	0.04
OW03-11	PF4/PI1	09 Jul 2018	7.04	1400	5.9	37	250	39	430	< 1.0	330	270	770	12	< 1.0	0.35	96	280	120	0.23	2.85	0.02	0.03
OW03-12	PF4	09 Jul 2018	7.41	480	1.9	11	84	7.4	84	< 1.0	190	160	250	4.9	< 1.0	0.11	21	100	98	0.40	1.62	0.02	0.05
OW03-29	PF4	09 Jul 2018	7.43	1300	100	26	130	220	70	< 1.0	310	250	430	2.7	< 1.0	0.04	28	180	210	0.70	1.69	0.50	2.98
OW13-07	PF4	11 Jul 2018	7.08	1500	230	16	68	160	170	< 1.0	470	390	240	11	< 1.2	0.079	460	110	220	2.22	0.61	2.12	2.82

Table 7-4 Groundwater Observation Sample Results – East MLSB Zone D

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: East of MLSB and South of Beaver Creek Valley Zone D																							
OW02-01	PF5A	08 Jul 2018	7.1	1600	210	23	88	260	96	< 1.0	360	290	320	16	< 1.0	0.11	< 20	110	73	1.25	1.06	1.45	4.57
OW02-02	PF4/ PF5A	08 Jul 2018	7.37	2200	370	25	83	360	79	< 1.0	600	490	310	27	< 1.0	0.032	130	99	100	1.59	0.63	2.60	9.77
OW02-03	PF4	08 Jul 2018	7.89	1000	140	6.9	27	210	27	< 1.0	150	130	97	9.2	< 1.0	0.028	< 20	38	40	1.03	0.77	3.18	10.82
OW02-04	PF4	08 Jul 2018	7.13	1600	170	34	130	220	120	< 1.0	440	360	460	17	< 1.0	0.11	< 20	140	170	1.19	1.28	0.80	2.96
OW04-07	PF4	08 Jul 2018	6.8	760	63	19	67	83	110	< 1.0	180	150	250	19	< 1.0	0.23	< 20	73	47	1.17	1.64	0.56	1.20

Syncrude

Table 7-5 Groundwater Observation Sample Results – East MLSB Zone E

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: North and East of MLSB and North of Beaver Creek Valley Zone E																							
OW80-14	unknown	27 Jun 2018	6.96	700	5.9	31	100	6.4	83	< 1.0	360	290	390	5.3	< 1.0	0.076	110	150	110	1.42	1.27	0.03	0.15
OW92-08	Kcc	07 Jul 2018	6.89	4200	300	150	400	98	1700	< 1.0	1300	1000	1600	24	< 1.0	0.34	540	3800	74	4.72	1.51	0.40	0.37
OW99-27	PF5A	25 Jun 2018	7.29	2400	330	38	110	220	200	< 1.0	930	770	440	28	4.3	0.88	450	410	350	2.32	0.56	1.67	3.44
OW99-28	PF5B	07 Jul 2018	7.14	3700	420	110	250	90	1600	< 1.0	730	600	1100	19	< 1.6	< 0.015	1100	2300	45	7.20	1.79	0.85	0.55
OW03-15	PF5B	25 Jun 2018	6.68	610	36	15	84	37	63	< 1.0	230	190	270	25	< 1.0	0.61	31	150	140	1.50	1.43	0.29	1.19
OW03-16	PF5A	26 Jun 2018	7.23	700	69	17	71	50	58	< 1.0	290	230	250	5.3	< 1.0	0.064	28	190	130	2.13	1.03	0.61	2.48
OW03-17	HAE/PF5A	26 Jun 2018	7.26	1100	150	16	82	78	100	< 1.0	450	370	270	17	< 2.3	0.25	26	130	130	2.97	0.73	1.21	3.13
OW04-01	PF4	25 Jun 2018	6.95	500	67	8.9	26	37	39	< 1.0	200	160	100	4.6	< 1.0	0.023	120	76	79	2.79	0.61	1.44	3.59
OW04-02	PF4	25 Jun 2018	7.36	2000	380	22	71	190	190	5.7	690	570	270	18	< 1.0	0.055	640	130	60	3.09	0.47	3.09	4.17
OW04-03	Pl3/PF4	26 Jun 2018	7.39	510	17	19	71	3	26	< 1.0	300	250	260	5.4	< 1.0	0.18	23	150	81	8.75	1.03	0.14	1.36
OW04-04	PF4/PL3/PGKM	26 Jun 2018	7.28	1100	140	17	83	110	93	< 1.0	380	320	280	17	< 1.6	0.22	150	120	230	1.96	0.89	1.10	3.14
OW04-05	PF4	27 Jun 2018	7.4	2100	380	24	68	220	200	< 1.0	730	600	270	18	< 1.7	0.071	610	120	76	2.67	0.45	3.08	3.97

Table 7-6 Groundwater Observation Sample Results – East MLSB T-Pit

Sample Location ID	Screen Lithology	Date	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: T-PIT Zone, east of MLSB (east of Zones B &C)																							
SP05-T05R		11 Jul 2018	7.07	2200	190	48	270	170	720	< 1.0	410	340	880	7.9	< 1.0	0.021	250	380	58	1.73	2.58	0.47	0.55
SP10-T047A	Devonian	03 Jul 2018	7.01	41000	11000	69	87	16000	< 1.0	< 1.0	2700	2200	500	35	7.9	6.6	2800	11000	8500	1.06	0.23	47.80	22956.52
SP10-T047B	4W	03 Jul 2018	6.76	48000	11000	120	120	19000	150	< 1.0	2500	2000	780	99	6	8.7	2300	13000	640	0.89	0.39	30.20	153.04

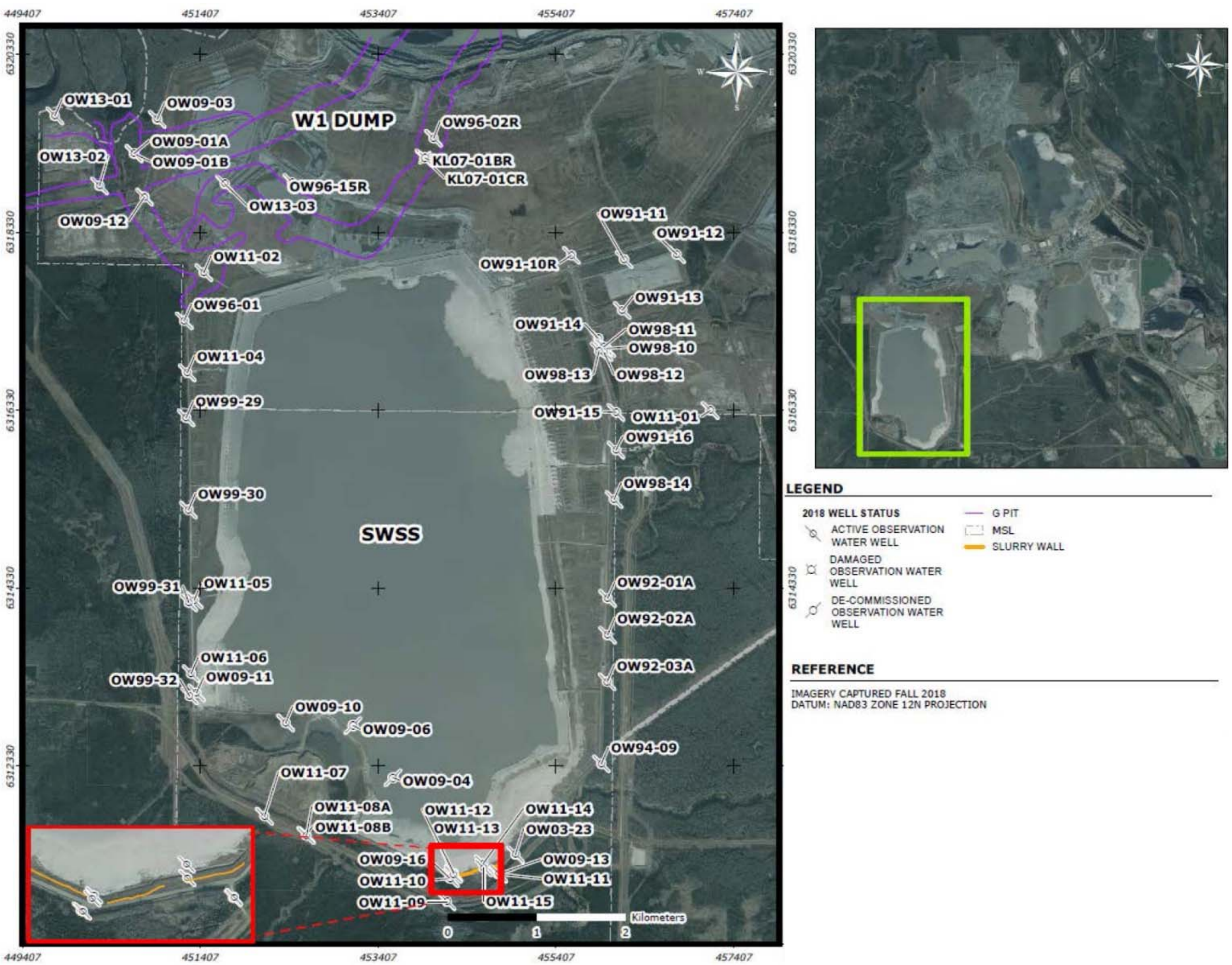

Figure 7-2 Groundwater Observation Well Locations – SWSS

Syncrude

Table 7-7 Groundwater Observation Sample Results – SWSS Area

Sample Location ID	Date	Screen Lithology	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: South West Sand Storage (SWSS) - East																							
OW11-01	27-Jun-18	Pl2/Pg3	7.11	4500	900	67	150	23	1400	< 1.0	1500	1200	640	19	< 1.0	0.091	2400	1800	33	60.40	0.53	3.01	1.34
OW91-10R	23-Jun-18	unknown	7.41	4000	950	25	51	300	590	< 1.0	1400	1200	230	11	< 1.0	1.4	2100	950	< 10	4.89	0.20	8.98	3.36
OW91-11	23-Jun-18	Pg3	7.07	1800	330	18	66	41	120	< 1.0	1000	830	240	11	< 1.0	0.55	1100	700	29	12.42	0.29	3.00	5.74
OW91-12	23-Jun-18	Pg1	6.9	3600	340	110	320	230	1200	< 1.0	710	580	1300	22	< 1.0	0.34	450	1700	14	2.28	2.14	0.59	0.59
OW91-13	23-Jun-18	Pl2/Pg3	6.69	2800	140	130	340	24	790	< 1.0	1200	950	1400	38	< 1.0	0.37	580	2000	87	9.00	1.40	0.22	0.37
OW91-14	27-Jun-18	Pg3	7.03	4000	460	110	400	89	1700	< 1.0	720	590	1500	23	< 1.0	0.39	690	2100	15	7.98	2.45	0.69	0.56
OW91-15	29-Jun-18	Pg3	7.19	3400	650	55	130	130	860	< 1.0	1100	930	550	16	< 1.0	0.82	1500	1600	25	7.72	0.61	2.57	1.58
OW91-16	29-Jun-18	Pg1	7.45	3500	760	31	70	240	260	< 1.0	1600	1300	300	12	< 1.0	0.77	2400	1600	26	4.89	0.23	5.47	6.10
OW92-01A	29-Jun-18	Pg3	6.72	4100	480	100	450	12	2300	< 1.0	630	520	1600	15	< 1.0	0.11	690	2500	< 10	61.74	2.96	0.68	0.44
OW92-02A	29-Jun-18	Pg3	7.19	5400	1100	63	180	47	2300	< 1.0	1200	950	700	20	< 1.0	1.2	2100	2200	< 10	36.12	0.72	3.38	1.00
OW92-03A	29-Jun-18	Pg3	7.07	4200	700	95	240	110	1400	< 1.0	1300	1100	990	28	< 1.0	0.083	760	2100	< 10	9.82	0.93	1.54	1.04
OW96-02R	17-Jul-18	Pf3	6.47	1300	80	37	140	19	130	< 1.0	680	560	500	12	< 1.0	0.73	350	1100	80	6.50	0.90	0.35	1.28
OW98-14	29-Jun-18	Pg1	6.97	3500	370	120	370	8.6	1700	< 1.0	750	610	1400	14	< 1.0	0.95	710	2700	15	66.41	2.30	0.57	0.45
Area: South West Sand Storage (SWSS) - South																							
OW03-23	29-Jun-18	Pl2/Pg3	7.21	1400	190	47	100	26	150	< 1.0	740	610	450	6	< 1.0	0.17	630	1200	47	11.28	0.73	0.93	2.64
OW09-10	5-Jul-18	Pf	9.15	980	250	0.45	0.95	4.3	5.6	80	460	510	4.2	4.5	< 1.0	0.68	860	48	14	89.74	0.01	128.81	93.17
OW09-13	3-Jul-18	Kcd/Kcc	8.29	2200	490	1.6	2.7	52	16	32	1300	1100	14	12	4	0.76	2800	210	69	14.54	0.01	80.05	63.91
OW09-16	5-Jul-18	Pg1	8.73	1400	310	1.3	3.2	18	8	21	830	710	13	8.5	< 1.3	0.53	2000	110	27	26.58	0.02	50.56	80.87
OW11-07	19-Jul-18	Kgr	6.5	1000	17	48	150	15	7.8	< 1.0	670	550	570	6.8	< 1.0	0.05	91	720	370	1.75	1.04	0.06	4.55
OW11-08A	19-Jul-18	Kgr	6.28	1900	87	63	200	190	200	< 1.0	700	580	750	14	< 1.0	0.14	170	1100	350	0.71	1.32	0.25	0.91
OW11-08B	19-Jul-18	Kcf	6.42	1000	28	58	120	27	4.2	< 1.0	670	550	540	7.3	< 1.0	0.3	200	1300	440	1.60	0.98	0.11	13.91
OW11-09	19-Jul-18	Pg1	8.96	1000	240	0.88	2.7	6.5	< 1.0	58	540	540	10	3.4	< 1.0	0.23	1000	60	18	56.99	0.02	50.38	500.87
OW11-10	5-Jul-18	Pg1	9.31	1200	280	3.1	8.5	15	11	16	740	640	34	5.9	< 1.0	0.27	1800	200	45	28.81	0.05	17.93	584.35
OW11-11	3-Jul-18	Pg1/Kcd	7.91	1500	290	15	28	20	45	< 1.0	920	760	130	7.4	< 1.0	0.96	1300	600	200	22.38	0.17	4.80	605.22
OW11-12	5-Jul-18	Kcd/Pg1	8.4	1700	350	13	30	30	78	< 1.0	1000	840	130	8.4	< 1.0	0.37	1700	590	210	18.01	0.16	5.93	9.36
OW11-13	5-Jul-18	Pg1/Pg3	8.29	1800	410	3.8	8.4	32	15	< 1.0	1100	940	37	8.5	< 1.0	0.65	2000	320	67	19.78	0.04	24.37	57.04
OW11-14	3-Jul-18	Pg1	7.51	1400	250	23	41	15	20	< 1.0	920	760	200	7	< 1.0	1.1	1300	850	320	25.72	0.26	2.76	26.09
OW11-15	3-Jul-18	Pg1	7.9	2300	620	4.9	7.7	38	100	29	1300	1200	39	14	< 1.0	0.85	2100	360	76	25.18	0.04	34.27	12.94
OW94-09	29-Jun-18	unknown	6.89	2800	360	88	220	6.2	1100	< 1.0	720	590	920	13	< 1.4	0.36	610	1700	13	89.62	1.54	0.86	0.68

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Table 7-7 Groundwater Observation Sample Results – SWSS Area (continued)

Sample Location ID	Date	Screen Lithology	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	Ammonia (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg)/(CO_3+ HCO_3) (meq/meq)	Na/(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: South West Sand Storage (SWSS) - West																							
OW09-11	5-Jul-18	Pf/Pl	7.4	940	160	20	33	4.7	12	< 1.0	610	500	170	4.6	< 1.0	0.89	540	510	160	52.54	0.33	2.11	27.83
OW11-02	5-Jul-18	Pg	6.72	2200	210	55	150	130	58	< 1.0	1200	1000	600	8.7	< 1.0	1.2	1400	3700	110	2.49	0.61	0.76	7.56
OW11-04	5-Jul-18	Pg1	7.43	2400	380	37	90	16	510	< 1.0	970	800	380	14	< 1.0	0.8	1500	1400	32	36.66	0.47	2.19	1.55
OW11-05	4-Jul-18	Kcd	7.17	960	94	45	54	30	27	< 1.0	560	460	320	2.8	< 1.0	0.2	250	490	100	4.84	0.69	0.64	7.27
OW11-06	5-Jul-18	Kcd	7.64	980	180	20	26	2.5	20	< 1.0	630	520	150	3.9	< 1.0	0.96	520	430	110	111.13	0.28	2.66	18.78
OW96-01	5-Jul-18	Pg1	7.72	3400	790	15	26	10	710	< 1.0	1400	1200	130	18	< 1.0	2	2200	1100	52	121.93	0.11	13.58	2.32
OW99-29	5-Jul-18	Pl1/Pg3	7.35	1100	130	24	74	2.9	150	< 1.0	540	440	290	12	< 1.0	0.036	330	440	22	69.19	0.64	1.00	1.81
OW99-30	5-Jul-18	Pg3	6.96	3000	360	88	230	17	1200	< 1.0	820	670	930	11	< 1.0	0.24	750	2100	14	32.69	1.39	0.84	0.63
OW99-31	5-Jul-18	Pg1	8.25	1200	280	2.5	2.7	4.1	44	5.8	690	570	17	4.5	< 1.0	0.64	910	150	35	105.41	0.03	35.81	13.28
OW99-32	5-Jul-18	Pg1	7.4	870	140	19	44	1.9	16	< 1.0	560	460	190	4.1	< 1.0	0.45	400	330	110	113.73	0.41	1.62	18.26
Area: South West Sand Storage (SWSS) - North																							
KL07-01CR	17-Jul-18	PF3	6.9	1900	230	39	110	110	180	< 1.0	830	680	440	13	2.2	0.63	590	680	47	3.23	0.64	1.15	2.67
OW09-01A	6-Jul-18	Pf	6.89	2200	70	100	300	1.2	860	< 1.0	670	550	1200	14	< 1.0	3.5	530	2300	13	90.04	2.11	0.13	0.17
OW09-01B	6-Jul-18	Pl	6.99	2300	70	110	320	1.8	880	< 1.0	720	590	1300	15	< 1.0	0.11	250	1300	24	60.02	2.11	0.12	0.17
OW09-03	26-Jun-18	Pf/Pf/Kc	6.83	1600	59	72	210	1.1	430	< 1.0	570	460	830	7.6	< 1.5	1	590	2100	13	82.79	1.75	0.16	0.29
OW09-12	26-Jun-18	Pf	7.18	1300	170	31	89	< 1.0	180	< 1.0	660	540	350	9.9	< 1.0	0.86	630	910	84	262.39	0.64	1.06	1.97
OW13-01	6-Jul-18	PF4	6.84	1200	46	47	150	2.1	180	< 1.0	640	520	570	12	< 1.5	0.66	260	800	46	33.81	1.08	0.18	0.53
OW13-02	6-Jul-18	Pf	6.9	1300	110	39	120	1.6	160	< 1.0	730	600	460	11	< 1.5	0.8	560	1000	38	106.11	0.77	0.52	1.43
OW13-03	17-Jul-18	PF5A	6.13	1800	41	62	260	< 1.0	550	< 1.0	600	490	910	7	< 1.0	0.52	260	960	< 10	63.28	1.83	0.10	0.16
OW96-15R	18-Jul-18	PF3/PG	6.87	1300	200	22	73	5.2	23	< 1.0	840	690	270	8.6	< 1.0	0.48	560	580	220	59.36	0.40	1.59	18.15

Figure 7-3 Groundwater Observation Well Locations – In-Pit Area

Table 7-8 Groundwater Observation Sample Results – In-Pit Area

Sample Location ID	Date	Screen Lithology	Field pH	Conductivity (µS/cm)	Na (mg/L)	Mg (mg/L)	Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Alkalinity (as mg/L of $CaCO_3$)	Hardness (Ca+Mg as mg/L of $CaCO_3$)	DOC (mg/L)	Naphthenic Acids (mg/L)	B (µg/L)	Sr (µg/L)	Ba (µg/L)	Na/Cl (meq/meq)	(Ca+Mg) /(CO_3+ HCO_3) (meq/meq)	Na /(Ca+Mg) (meq/meq)	Na/SO_4 (meq/meq)
Area: West In-Pit (WIP)																						
BML96-03	12-Jul-18	Devonian	7.02	23000	5000	97	95	7200	110	< 1.0	2300	1900	640	27	1.9	3200	8800	540	1.07	0.34	17.12	94.86
BML96-04R	3-Jul-18	Devonian	9.3	29000	6700	130	100	11000	100	< 1.0	1000	820	810	19	2.7	1800	8800	550	0.94	0.95	18.61	139.83
BML96-05	20-Jul-18	Devonian	7.15	17000	3600	56	100	4500	< 1.0	< 1.0	3400	2800	480	< 13	6.1	5100	4400	2500	1.23	0.17	16.32	7513.04
BML97-09R	3-Jul-18	4/4W	6.58	54000	13000	160	140	20000	< 1.0	< 1.0	2700	2200	1000	50	< 1.0	2400	23000	2300	1.00	0.45	28.10	27130.43

8 Environmental Aspects of Tailings Research and Development

Syncrude undertakes environmental research in collaboration and partnership with academic institutions across Canada and North America. Through these partnerships, findings are published in peer reviewed journals, books and conference proceedings available in the public domain. Additional technical details for a majority of the research activities can be found in the 2016[1] and 2017[2] COSIA Land Environmental Priority Area (EPA) Mine Site Reclamation Research Annual Reports which provides program objectives, summary of results, and a list of peer reviewed journal publications.

8.1 Watershed Research on Tailings Substrates

Watershed research makes up a portion of Syncrude's reclamation research portfolio, supporting a holistic understanding and assessment of landform performance that cannot be achieved by an individual research activity. Watershed research generates knowledge that is used to support overall program objectives of developing best practices (in areas of landform design, soil cover design, and revegetation). Uncertainty in future performance can be reduced through development of predictive models based on the record of performance acquired. Watershed sites also provide climatic, water quality, and water yield information from reclaimed landscapes. This information is important to interim and closure water management. Additionally, the information collected from instrumented watersheds will help to benchmark progress and, ultimately, demonstrate acceptability for final closure.

Watershed research programs include forest, aquatic and wetland ecosystem research. The Base Mine Lake Demonstration (BML) and Sandhill Fen Research watershed programs constitute the majority of aquatic and wetland ecosystem research. Watershed research on tailings substrates include:

- Southwest Sand Storage (SWSS) on tailings sand,
- Base Mine Lake Demonstration (BML) of water capped fluid fine tailings, and
- Sandhill Fen Research Watershed on tailings sand capped composite tailings.

8.1.1 Southwest Sand Storage (SWSS) on Tailings Sand

The Southwest Sands Storage research watershed was commissioned in 2001 focusing on geophysics, geochemistry, hydrology, salt transport and vegetation performance. Southwest Sands Storage is a tailings and recycle water storage facility located in the southwest corner of the Mildred Lake site. Meteorological and soil data collection and legacy research reporting continue on SWSS to support current and future research.

[1] https://www.cosia.ca/sites/default/files/attachments/COSIA_Land_Mine_Site_Reclamation_Report_2016.pdf
[2] https://www.cosia.ca/sites/default/files/attachments/COSIA Annual Report 2017_MAR26_FINAL.pdf

An IRC in Hydrogeological Characterization of Oil Sands Mine Closure Landforms is to develop methods of characterizing, monitoring, and simulating water movement through reconstructed oil sands landscapes. The development of the investigative and interpretative tools are focused on the evolving hydrogeology of two of the largest oil sands landscapes: overburden shale (South Bison Hills) and tailings sands (SWSS).

From 1997 to 2011, Innotech Alberta (formerly the Alberta Research Council) undertook a research program that monitored soil, water and vegetation at select locations at SWSS and compared it to control sites in the area to determine the effect of tailings seepage water on reclamation at SWSS. A final report found the following key findings:

- Solute transport (and resulting electrical conductivity [EC] and sodium adsorption [SAR]) at SWSS follows normal recharge/discharge water flow dynamics; topographic highs flush ions creating lower EC and SAR, while lower slopes linked to seepage water accumulate ions and have increased EC and SAR.
- Lower slope positions flush salts and sodium during increased precipitation (allowing flushing), suggesting increased sodicity to date has not restricted soil-water flow.
- Increases in sodium and select elements in plant tissues were found, but vegetation remained healthy through the life of the project.

The list of recently completed, active and future projects on SWSS is provided in Table 8-1.

Table 8-1 Southwest Sand Storage Research Projects

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
SOUTHWEST SANDS STORAGE (SUBTRATE: TAILINGS SAND)			
Long Term Hydrometric Monitoring	O'Kane	Various Consultants	6.1.56a (v,vi) 6.1.56b (i,iii,v,vi)
Industrial Research Chair in Hydrogeological Characterization of Oil Sands Mine Closure Landforms	U of S	Lee Barbour	6.1.56a (v,vi)
Seepage water effects on soil/plants in SWSS long term ARC monitoring	Innotech Alberta	Bonnie Drozdowski	6.1.56a (viii) 6.1.56b (v)

8.1.2 Base Mine Lake on Water Capped Fluid Fine Tailings

BML is the first commercial-scale demonstration of the end pit lake technology in the oil sands industry. An oil sands end pit lake (EPL) is an area where overburden and oil sand has been removed and is then filled with fluids prior to closure. An EPL contains water (from the process of oil sands extraction or freshwater or both) and may or may not contain fine fluid tailings (FFT), treated fluid tailings (FT) or other solids (for example, coarse tailings sand, or overburden).

BML is located in the former West In-Pit (WIP) of the Syncrude Mildred Lake (Base Lease) operation. It consists of a mined out oil sands pit filled with fluid fine tailings (silt, clay, process-affected water and residual bitumen) that sits below a combination of oil sands process-affected water (OSPW) and fresh water. This pit lake configuration is often referred to as water capped tailings technology (WCTT). Based on previous research and modelling, the prediction for WCTT is that with time, EPL water quality improves and the FFT (or other tailings) will remain sequestered below the water cap.

Infrastructure has been installed to pump water in from Beaver Creek Reservoir (BCR) and pump water out to the tailings recycle water system (RCW) until a more substantial upstream surface watershed is reclaimed and connected to BML, and outflow is established into the Athabasca River. This process dilutes the BML water cap over time.

Placement of FFT began in 1995, was completed in late 2012, and BML was commissioned as of December 31, 2012. No tailings solids were added or removed after this time. During 2013, fresh water and OSPW was added to the existing OSPW upper layer to attain a final water elevation of 308.7 metres above sea level (masl).

The objective of the BML Monitoring and Research Program (MRP) is to validate WCTT for a FFT filled lake. The outcomes from the BML MRP will be useful for other pit lakes that may contain other tailings materials, including treated tailings. At the same time, the program establishes a baseline of biophysical data to assess the state of the lake at certification, including water quality and other lake processes. The monitoring program is designed to track trends in the lake both seasonally and annually, and measure these trends against some key performance metrics. The research program focuses on key scientific questions designed to elucidate the mechanisms and processes that govern the current state of BML, and explain changes detected by the monitoring program. In other words, the monitoring program tracks the trends in the lake through time, and the research program investigates why those changes are occurring.

Over the next 5-10 years critical information will be gathered on key metrics, as well as an understanding of processes occurring within BML. The list of active and future projects on BML and other aquatic research activities is provided in Table 8-2.

Table 8-2 Base Mine Lake Research Projects

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
BASE MINE LAKE (SUBSTRATE: WATER CAPPED FFT)			
BML Monitoring (including data collection, data management, analysis and reporting)	Hatfield Consultants / ConeTec Investigations / O'Kane / BARR Engineering /EMIT	Various Consultants	6.1.56b (i-vi)
Laboratory studies investigating chemical flux across tailings–cap water zones, simulating an End Pit Lake in the Athabasca oil sands region	U of A	Ania Ulrich	6.1.56b (i,v,vi)
Characterization of controls on mass loading to an oil sands end pit lake	U of S	Lee Barbour/ Matt Lindsay	6.1.56b (i,v,vi)
Physical Limnology of BML and the potential for meromixis	UBC	Greg Lawrence	6.1.56b (i,v,vi)
Microbial communities and methane oxidation processes in BML	U of C	Peter Dunfield	6.1.56b (i,v,vi)
Field Investigation of BML Water Cap Oxygen Concentrations, Consumption Rates and Key BOD/COD Constituents Affecting Oxic Zone Development	McMaster, U of T	Lesley Warren	6.1.56b (i,v,vi)

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
Understanding Water-Air Exchanges and the Long Term Hydrological Viability of Base Mine Lake	McMaster	Sean Carey	6.1.56b (ii,v,vi)
OTHER AQUATIC RESEARCH ACTIVITIES			
NSERC Industrial Research Chair (IRC) in Oil Sands Process Water (OSPW) Organics Treatment (Term 2)	COSIA (EPA)	Mohamed Gamal El Din	6.1.56a (iv)
Monitoring Avian Productivity and Survivorship (MAPS) and Wildlife Monitoring	COSIA (JIP)	Samantha Tavener, OMEI	6.1.56b (iii)
Annual Industrial Waste Water Monitoring (Free and pore water chemical characterization)	Syncrude	Warren Zubot	6.1.56a (iv), b (i, ii, iii)
Additional Naphthenic Acid Studies – Bioaccumulation and Persistence	COSIA (EPA)	Aaron Redman	6.1.56a (iv), b (ii)
Treatment Wetland Field Pilot Pre-work	COSIA (EPA)	Clemson University, Joshua Martin	6.1.56b (v)
Literature Review and Evaluation of Chloride Water Guidelines for Water Return	COSIA (EPA)	Warren Zubot	6.1.56a (v), b (iii)
Support Studies (e.g., bioaccumulation) for OSPW return	COSIA (EPA)	Warren Zubot	6.1.56b (ii), (iii)

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
Cultivating the uncultivatables	COSIA (EPA)	OPE, Rodney Guest	6.1.56a (iv), b (ii)
Demonstration Pit lakes	COSIA (JIP)	Stephen Tuttle	6.1.56b (i), (ii), (iv)
Natural and Anthropogenic inputs to the Athabasca River	COSIA (JIP)	Warren Zubot	6.1.56b (v)
Evaluation of passive solar photocatalytic treatment of OSPW	COSIA (JIP)	University of Waterloo, Theo Paradis	6.1.56a (iv)
Target Lipid Model for Acid Extractable Organics – Phase 2	COSIA (JIP)	Asfaw Bekele	6.1.56a (iv), b (ii)

8.1.3 Sandhill Fen on Composite Tailings

The Sandhill Fen Research Watershed (SFRW) is a large scale pilot wetland research watershed program designed to address two challenges in oil sands reclamation and closure: 1) the ability to re-establish initial conditions for the development of fen wetlands over time and 2) technology and practices for reclamation of soft tailings.

The Sandhill Fen Research Watershed is located in the North West corner of Syncrude's East In-Pit (EIP). EIP is the former east mine, which was actively mined from 1978 - 2000. Since mining, the SFRW area of EIP has been filled with CT and capped with tailings sand. SFRW is approximately 55 hectares, and includes a nearly 17 hectares primary wetland surrounded by upland area with 7 hummocks, 2 perched fens and associated infrastructure (roads, research center, boardwalks). The hummocks were constructed with mechanically placed tailings sand directly on top of the tailings sand cap. The SFRW instrumented watershed research involves intensive monitoring of constructed landforms which enable the execution of concurrent, integrated, multi-disciplinary research programs. Central to the watershed approach are the determination of: water and energy balances, mass balances and plant and ecological responses.

A list of active wetland research projects on the SFRW is provided in Table 8-3.

Table 8-3 Sandhill Fen Research Watershed Projects

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
SANDHILL FEN RESEARCH WATERSHED (SUBSTRATE: COMPOSITE TAILINGS)			
Water and Carbon Balance in the Constructed Fen	McMaster	Sean Carey	6.1.56b (v)
The Early Development of Sandhill Fen: Plant Establishment, Community Stabilization, and Ecosystem Development	Southern Illinois	Dale Vitt	6.1.56b (iv)
The Ecology of Sandhill Fen – years 5-8 (July 1, 2016 – March 31, 2020): Monitoring of key ecological functions and establishment of markers of success for peatland reclamation	Southern Illinois	Dale Vitt	6.1.56b (iv)
Forest Reconstruction on Upland Sites in the Sandhill Fen Watershed	U of A	Simon Landhausser	6.1.56a (ii,vi,vii)
Hydrogeological Investigation of Sandhill Fen and Perched Analogues	U of A	Carl Mendoza / Kevin Devito	6.1.56a (iv,v,vi) 6.1.56b (v, vi)

8.2 Forest Ecosystem Research

Vegetation is a key indicator of reclamation performance. In order to meet Syncrude's commitment to returning land to equivalent capability we must understand the effects of reclamation practices on plant community establishment. This includes a better understanding of the effect of topography, cover soil/subsoil and substrate characteristics, and a host of vegetation treatments on plant community development.

Revegetation research is aimed at understanding the optimum assemblage of plants given a particular set of reclamation circumstances. This research includes the study of traditionally planted seedlings, but it also includes less well known and locally important understory species that could be important components of future ecosystems.

In addition to the revegetation research being conducted as part of the integrated watershed studies, a number of individual revegetation research activities were advanced during the reporting periods, which have applicability for tailings sand reclamation.

8.2.1 A Forest Fertilization Trial in a Mildred Lake Jack Pine Stand

This study investigates application of fertilizers in a controlled experiment on a reclaimed 19-year old (at start of study) jack pine stand that has reached canopy closure. The soil cover design is a direct placement of peat-mineral mix to target depth of 50 cm directly over tailings sand. The hypothesis is that fertilizer blends identified during an initial screening trial would result in increases in tree growth. The initial screening trial employed 16 exploratory fertilizer treatments applied to 80 two-tree plots (five replicates per treatment). Vector analysis of changes in needle mass and foliar nutrient content after the first growing season was used to recommend fertilizer rates and formulations for the main trial. Final treatments included nitrogen (N), phosphorus (P), sulfur (S), potassium (K), and the micronutrients copper (Cu) and magnesium (Mg) formulated as
NPS and NPKS + Cu and Mg.

8.2.2 Industrial Research Chair in Forest Land Reclamation

A pressing objective of mine reclamation in the boreal forest region is to return disturbed sites to fully functioning and self-sustaining ecosystems. Early in the recovery of forests, the main challenge is rapid re-development of a tree canopy to create conditions that initiate and sustain abiotic and biotic processes characteristic of functioning forest ecosystems. Building on work in an earlier phase of this chair, the renewal of the IRC program is examining critical issues related to growth constraints, such as limited soil nutrients and high competition, during stand initiation and development. In addition, it is exploring the use of different topographical features to promote more spatially diverse site conditions resulting in more diverse plant communities.

8.2.3 Selected Willow Clones for Use in Reclaimed Ecosystems Impacted by Elevated Salt Levels

Many species of willow commonly occur in the environments most at risk from exposure to OSPW, and are frequently a major structural component of lowland and riparian ecosystems. Willows are often deployed early in the reclamation of these areas based on their value for slope and shoreline stabilization. As such, they often play an important role in oil sands mine reclamation efforts. A recent greenhouse study conducted by Natural Resources Canada (NRCan) has identified several clones of various native willow species that appear to have particularly high tolerance to OSPW. The current study is a field deployment of 15 native willow clones previously identified as having the highest tolerance levels.

8.2.4 Native Balsam Poplar Clones for Use in Reclamation of Salt Impacted Sites

The main objective of this research is to identify and select balsam poplar clones from the Alberta-Pacific (Al-Pac) Controlled Parentage Program Plan (PB1–CPP) for balsam poplar (Populus balsamifera) that are well adapted to, and are appropriate for planting on growing sites challenged with elevated dissolved salt concentrations on reclaimed oil sands mine sites. It is hypothesized that balsam poplar clones exhibiting tolerance to salts in greenhouse trials (identified by exposure to varying concentrations of OSPW) will have higher survival and increased growth on reclamation sites than either: i) poplar clones tested with OSPW that did not exhibit tolerance to elevated salt concentrations, or ii) a local Stream I Syncrude balsam poplar cutting collection. The null hypothesis is that no such differences exist.

8.2.5 Developing a Functional Approach to Assessment of Equivalent Capability

This project seeks to develop an alternate approach to the assessment of equivalent capability and reclamation performance directly based on, and linked to, ecosystem function, by leveraging long-term eco-hydrological research that measures growing-season water and carbon balances across a range of reclaimed land and recovering boreal forest ecosystems. The project seeks to develop correlations between detailed and expensive measured of ecosystem function such as carbon and moisture fluxes above plant canopies, and simpler measures of ecosystem status such as Leaf Area Index or Basal Area, thus providing cost effective indicators of ecosystem function levels.

A list of revegetation research projects is provided in Table 8-4.

Table 8-4 Forest Ecosystem Research Projects

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
REVEGETATION RESEARCH			
A Forest Fertilization Trial In A Mildred Lake Jack Pine Stand	UBC	Bruce Larson	6.1.56a (ii)
Industrial Research Chair in Forest Land Reclamation	U of A	Simon Landhausser	6.1.56a
Selected Willow Clones for Use in Reclaimed Ecosystems Impacted by Elevated Salt Levels	NRCAN	Richard Krygier	6.1.56a (vii)
Native balsam poplar clones for use in reclamation of salt impacted sites	Al-Pac	Barb Thomas	6.1.56a (vii)
Developing a functional approach to assessment of equivalent capability: utilizing ecosystem water, carbon and nutrient fluxes as integrated measures of reclamation performance.	IEG /	Justin Straker	6.1.56a
	McMaster	Sean Carey	

8.3 Other Tailings Related Research

The collection of projects described in this section includes programs that are assessing tailings substrates outside of a specific watershed research program, studying multiple tailings substrates/ watersheds, or providing guidance for landforms containing tailings substrates.

8.3.1 NSERC IRC: Mine Closure Geochemistry

Syncrude continues to sponsor the NSERC Industrial Research Chair entitled Mine Closure Geochemistry. This study is focused on the characterization of geochemical properties of select processed materials used in landscape reconstruction. The research approach can be applied to any novel tailings or other material type contemplated for use in the reconstructed landscape and, coupled with an understanding of hydrologic and/or geotechnical data and modelling can provide early assessments of a materials potential environmental performance.

8.3.2 Innotech Alberta Soil Research

Innotech Alberta conducted two programs that monitored specific aspects of land reclamation; these were Long Term Soil Development (LTSD) and Carbon Dynamics in Reclamation Landscapes (C Dynamics). The objective of the LTSD program was to assess long term soil moisture and bulk in reclaimed soil profiles to determine if changes in these key soil physical properties occur over time as the soil profile evolves and vegetation growth occurs (and demands for water resources increases). Annual monitoring took place over each growing season from 1992 and concluded in 2014. A final report was completed and found the following key findings related to tailings sand reclamation:

- Long-term soil moisture status of the range of tailings sand soil cover designs employed by Syncrude fall in a range between native Brunisol and Luvisol soils.
- Slope position plays an important role in expanding the range of soil-water status of reclaimed soils; upper slope positions were found to be drier than lower slope positions.
- Reclamation capping thickness plays a role in expanding the range of soil-water status, but did not have as great of an impact on extending the range as slope position.

The objective of the C Dynamics project was to measure changes in carbon pools or stocks for a range of Syncrude reclaimed soils to evaluate carbon pool changes that take place in reclamation areas over time. Annual monitoring took place over each growing season beginning in 2000 and concluded in 2014.

8.3.3 Nutrient Biogeochemistry

Syncrude is part the multi-industry, NSERC funded Nutrient Biogeochemistry 2: tracking nutrient fluxes through reconstructed soils (NBGC II) research program. This research is studying the establishment of biogeochemical cycling of soil materials used in reclamation (peat/peat-mineral mix of organic peat soils and mineral subsoil) and plants that re-establish. This program will provide guidance on the appropriate coversoil capping material(s) and placement depth(s) for reclamation of tailings sand.

8.3.4 Reclamation Research Technical Advisory Committee Capping Study on Tailings Sand

A soil capping study that was established by the Reclamation Research Technical Advisory Committee (RRTAC) in 1990 and originally monitored until 1997 was re-evaluated and was reported on in 2017. This project is testing capping depths ranging from 40 to 80 cm over tailings sand.

A list of other tailings research projects is provided in Table 8-5.

Table 8-5 Other Tailings Research Projects

Reclamation Research / Monitoring Program	Collaborators		Approval Clauses
	Vendor Name	Vendor Technical Lead	Meet / Support
OTHER TAILINGS RELATED RESEARCH			
Long Term Hydrometric Monitoring	O'Kane	Various Consultants	6.1.56b (v,vi)
Industrial Research Chair in Mine Closure Geochemistry	U of S	Matt Lindsay	6.1.56a (iv,v,viii) 6.1.56b (i,ii,iii,v,vi)
Long Term Soil Development	AITF	Bonnie Drozdowski	6.1.56a (ii)
Carbon Dynamics in Reclamation Landscapes	AITF	Bonnie Drozdowski	6.1.56a (ii)
Nutrient Biogeochemistry 2: tracking nutrient fluxes through reconstructed soils	U of A	Sylvie Quideau	6.1.56a (ii)
RRTAC Capping Study on Tailings Sand	UBC	Bruce Larson	6.1.56a (ii)

Appendix A - Acronyms and Abbreviations

ADW	Accelerated Dewatering
ADW1	Accelerated Dewatering Phase 1
ADW2	Accelerated Dewatering Phase 2
ADW3	Accelerated Dewatering Phase 3
AER	Alberta Energy Regulator
BCPT	Ball Cone Penetrometer Test
BML	Base Mine Lake (also used interchangeably with WIP)
CADD	Computer-aided design and drafting
COSIA	Canada's Oil Sands Innovation Alliance
CT	Composite Tailings
EC	Electrical Conductivity
EIP	East In-Pit
El	Elevation
EPA	Environmental Priority Area
EPEA	Environmental Protection and Enhancement Act
EPL	End of Pit Lake
EW Dyke 1	East-West Dyke 1
E-W	East-West
fFFT	Flocculated Fluid Fine Tailings
FFT	Fluid Fine Tailings
FGD	Flue Gas Desulphurization
FT	Fluid Tailings
GCPTu/GCPT	Gamma Cone Penetration Testing
ha	Hectare
IRC	Industrial Research Chair
km	Kilometer
LTSD	Long Term Soil Development
m	Metres
m^3	cubic meter
Mm^3	Million cubic meters
MLSB	Mildred Lake Settling Basin
MRP	Monitoring and Research Program
Mt	Million tonnes
N/A	Not Applicable
NMSP	North Mine South Pond
NMSPE	North Mine South Pond East
NMSPW	North Mine South Pond West
NMSPW Jr	North Mine South Pond West Junior
NRCan	Natural Resources Canada
NS Dyke	North-South Dyke
NSERC	Natural Sciences and Engineering Research Council of Canada
N-S	North-South
OSPW	Oilsand Process Water
RCW	Recycle Water

Rev	Revision
RRTAC	Reclamation Research Technical Advisory Committee
RTR	Ready To Reclaim
SAR	Sodium Adsorption
SCT	Straight Coarse Tails
SERP	Syncrude Emissions Reduction Project
SFR	Sand to Fines Ratio
SFRW	Sandhill Fen Research Watershed
SWIP	South West In-Pit
SWIP Jr	South West In-Pit Junior
SWIP Maj	South West In-Pit Major
SWISA	Special Waste Interment Storage Area
SWSS	Southwest Sand Storage
VST	Vane Shear Testing
W1	W1 Overburden Dump
W4	W4 Overburden Dump
WCTT	Water Capped Tailings Technology
WIP	West In-Pit (also used interchangeably with BML)

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Appendix B - Fluid Tailings Management Reporting for 2018 (AER Letter)

Alberta Energy Regulator

Calgary Head Office
Suite 1000, 250 – 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

November 15, 2018

By email only

Rochelle Young
Regulatory Advisor
Syncrude Canada Ltd.
P.O. Bag 4023
Fort McMurray, AB T9H 3H5

Young.Rochelle@syncrude.com

RE: Fluid Tailings Management Reporting for 2018 – Mildred Lake

Dear Ms. Young,

Directive 085: Fluid Tailings Management for Oil Sands Mining Projects requires operators to submit annual management reports in electronic format to the Alberta Energy Regulator (AER) by April 30 for the previous year's performance (January to December).

The AER acknowledges that Syncrude does not have an approved fluid tailings management plan for the Mildred Lake site. The AER also acknowledges that certain fluid tailings management monitoring typically occurs during the spring and summer season. The AER understands that the absence of an approved fluid tailings management plan may impact Syncrude's ability to monitor and report all requirements in accordance with *Directive 085*.

To ensure consistency across operators, the AER requires that the following information on tailings related activities in 2018 be submitted by April 30, 2019. This information will support the public reporting mandated under the *Lower Athabasca Region: Tailings Management Framework for the Mineable Athabasca Oil Sands.*

- A summary of fluid tailings management activities during the reporting period, including fluid tailings treatment and placement operations, technology development, and contingency or mitigation activities initiated in response to inadequate deposit performance
- A table showing
    - the volume and composition of each deposit containing fluid tailings (fluid tailings volumes determined in accordance with *Directive 085)*
    - the volume of legacy, new and total fluid tailings for 2016, 2017, and 2018
- Describe if and how activities have deviated from the fluid tailings management plan and any modifications made to improve performance.

- Provide a site-wide water balance or provide the reference to another AER report and location where this information can be obtained
- Provide a water volume (in tabular form) or provide the reference to another AER report and location where this information can be obtained. The table must include, for each treated tailings deposit and fluid tailings pond,
  - total volume of water at the beginning of the reporting period,
  - total volume of water at the end of the reporting period, and
  - the volume and quality of water recovered from fluid tailings
- Provide information about fines that were not captured, which form fluid tailings, including
  - quantity of fines in the ore processed during the reporting period, and
  - quantity of fines in fluid tailings
- Provide a status map of the current locations and sizes of all fluid tailings ponds and treated deposits for the project
- Provide tonnage of ore processed and average composition (bitumen, water, solids) or provide the reference to another AER report and location where this information can be obtained
- For each fluid tailings treatment technology,
  - provide volume of fluid tailings treated and where they were placed;
  - provide expected properties of the treated fluid tailings compared to the actual properties achieved through treatment; and
  - if the technology is not performing as predicted, provide mitigation measures to rectify performance (address any impacts on the deposit performance)
- For each treated tailings deposit and fluid tailings ponds and their surrounding environment provide monitoring results, including the following:
  - a map and tabular data showing the survey locations of tailings deposits
  - representative cross-sections to illustrate the variation of tailings characteristics
- Description of the treatment technologies' operation over the reporting period, including issues that were encountered and a summary of continuous improvement activities
- Confirmation that technology development was implemented as proposed in the approved fluid tailings management plan by summarizing relevant activities in the reporting year. Confirm that technology development will continue to be implemented as stated in the approved fluid tailings management plan
- A technical report, within the constraints of proprietary information, on the progress of any pilots, prototypes, or demonstrations of fluid tailings technologies
- An assessment, within the constraints of proprietary information, of performance, successes, challenges, and implications for net environmental effects for all treatment technologies. The assessment may incorporate information references to other required reports, such as the tailings research report and groundwater monitoring report submitted under EPEA
- To assess operator performance in managing and minimizing environmental effects and implications associated with fluid tailings management activities, the annual management report must provide a

summary of the results from environmental performance monitoring reports related to fluid tailings management activities.

The AER may request additional information as it continues to evaluate the information needed to develop the new regulatory system for managing tailings. Questions should be directed to Rod Godwaldt at 403-355-5133 or rod.godwaldt@aer.ca.

Sincerely,

Rod Godwaldt
Mining Engineer

cc: Charles MacDonald, AER
Steven Van Lingen, AER

Syncrude

Appendix C - Deposit Measurement Locations Tabular Format

Mildred Lake - MLSB 2018 Testing Locations			
Test Hole ID	**Test Type**	**Northing (MM)**	**Easting (MM)**
MLSB-18-001	GCPTu	51943	50486
MLSB-18-002	GCPTu	51861	50730
MLSB-18-003	GCPTu	52162	50575
MLSB-18-004	GCPTu	52082	50767
MLSB-18-005	GCPTu	52894	51438
MLSB-18-006	GCPTu	52877	51566
MLSB-18-007	GCPTu	53014	51610
MLSB-18-008	GCPTu	53154	51507
MLSB-18-009	GCPTu	53297	51679
MLSB-18-01-14	GCPTu	54641	51184
MLSB-18-010	GCPTu	53437	51803
MLSB-18-011	GCPTu	53484	51628
MLSB-18-012	GCPTu	53571	51802
MLSB-18-013	GCPTu	53662	52046
MLSB-18-014	GCPTu	53658	52216
MLSB-18-015	GCPTu	53696	52495
MLSB-18-016	GCPTu	53771	52388
MLSB-18-017	GCPTu	53999	52374
MLSB-18-018	GCPTu	54236	52562
MLSB-18-019	GCPTu	54496	52600
MLSB-18-02-14	GCPTu	55145	51249
MLSB-18-020	GCPTu	54410	52432
MLSB-18-021	GCPTu	54383	52219
MLSB-18-022	GCPTu	54861	52358
MLSB-18-023	GCPTu	54342	51147
MLSB-18-024	GCPTu	54918	51250
MLSB-18-025	GCPTu	54173	51670
MLSB-18-026	GCPTu	54800	51720
MLSB-18-063	GCPTu	52393	50891
MLSB-18-102	GCPTu	52714	51192
MLSB-18-130	GCPTu	52911	51253
MLSB-18-134	GCPTu	52793	51640
MLSB-18-160	GCPTu	53167	51096
MLSB-18-353	GCPTu	53830	51754
MLSB-18-374	GCPTu	54117	51098
MLSB-18-401	GCPTu	54249	51346
MLSB-18-402	GCPTu	54077	51932
MLSB-18-403	GCPTu	53892	51252
MLSB-18-407	GCPTu	54489	51315
MLSB-18-413	GCPTu	54580	52287
MLSB-18-416	GCPTu	55072	52052
MLSB-18-417	GCPTu	54704	52536
MLSB-18-421	GCPTu	55019	52219
MLSB-18-424	GCPTu	55433	51190

MLSB-18-425	GCPTu	55297	51676
MLSB-18-426	GCPTu	55185	52039
MLSB-18-429	GCPTu	55436	51508
MLSB-18-430	GCPTu	55307	51895
MLSB-18-433	GCPTu	55637	51257
MLSB-18-434	GCPTu	55534	51322
MLSB-18-437	GCPTu	55783	51099
MLSB-18-438	GCPTu	55643	51410
MLSB-18-440	GCPTu	55927	50913
MLSB-18-441	GCPTu	55814	51313
MLSB-18-444	GCPTu	55974	51158
MLSB-18-453	GCPTu	56074	51061
MLSB-18-456	GCPTu	56341	50933
MLSB-18-460	GCPTu	56374	51260
MLSB-18-500	GCPTu	52830	51852
MLSB-18-501	GCPTu	52988	51659
MLSB-18-506	GCPTu	53267	51776
MLSB-18-508	GCPTu	53326	51921
MLSB-18-510	GCPTu	53405	52036
MLSB-18-517	GCPTu	53870	51859
MLSB-18-518	GCPTu	53794	52152
MLSB-18-526	GCPTu	55561	51458
MLSB-18-M02	GCPTu	56198	50857
MLSB-18-M07	GCPTu	55376	51369
MLSB-18-M09	GCPTu	55086	51850
MLSB-18-M13	GCPTu	54509	51804
MLSB-18-M14	GCPTu	54556	52529
MLSB-18-M17	GCPTu	53505	51026
MLSB-18-M18	GCPTu	53641	51368
MLSB-18-M19	GCPTu	53404	51668
MLSB-18-M20	GCPTu	53937	52049
MLSB-18-M21	GCPTu	53138	51764
MLSB-18-M23	GCPTu	52930	50838
MLSB-18-M24	GCPTu	52816	51354
MLSB-18-M28	GCPTu	54175	52263
MLSB-18-M29	GCPTu	53195	51345
MLSB-18-M36	GCPTu	52559	51034
MLSB-18-M38	GCPTu	53594	52096
MLSB-18-M41	GCPTu	52362	50671
MLSB-18-P6C1	GCPTu	53466	52255
MLSB-18-P6C2	GCPTu	53606	52425
MLSB-18-016	Sample	53772	52388
MLSB-18-020	Sample	54410	52431
MLSB-18-02-14	Sample	55145	51249
MLSB-18-160	Sample	53166	51096
MLSB-18-403	Sample	53892	51253
MLSB-18-416	Sample	55072	52052

MLSB-18-434	Sample	55535	51321
MLSB-18-453	Sample	56075	51059
MLSB-18-501	Sample	52987	51659
MLSB-18-508	Sample	53326	51921
MLSB-18-M13	Sample	54507	51804
MLSB-18-M19	Sample	53404	51671
MLSB-18-M20	Sample	53937	52051
MLSB-18-M24	Sample	52817	51354
MLSB-18-M38	Sample	53593	52097
MLSB-18-M41	Sample	52361	50671

Mildred Lake - SWSS 2018 Testing Locations			
Test Hole ID	Test Type	Northing (MM)	Easting (MM)
SWSS-18-002	GCPTu	47842	40726
SWSS-18-051	GCPTu	46081	41015
SWSS-18-112	GCPTu	44997	39548
SWSS-001	CT-09	47256	40252
SWSS-002	CT-09	47247	40549
SWSS-003	CT-09	47252	40850
SWSS-004	CT-09	47241	41149
SWSS-005	CT-09	47250	41447
SWSS-006	CT-09	47245	41752
SWSS-007B	CT-09	47251	42053
SWSS-008	CT-09	47247	42348
SWSS-009C	CT-09	47249	42255
SWSS-010	CT-09	46952	40256
SWSS-011	CT-09	46953	40542
SWSS-012	CT-09	46948	40850
SWSS-013	CT-09	46950	41145
SWSS-014	CT-09	46948	41454
SWSS-015	CT-09	46950	41748
SWSS-016	CT-09	46950	42049
SWSS-017	CT-09	46949	42349
SWSS-018	CT-09	46951	42255
SWSS-019	CT-09	46649	40248
SWSS-020	CT-09	46649	40551
SWSS-021	CT-09	46653	40854
SWSS-022	CT-09	46651	41150
SWSS-023	CT-09	46652	41457
SWSS-024	CT-09	46655	41758
SWSS-025	CT-09	46650	42054
SWSS-026	CT-09	46651	42350
SWSS-027	CT-09	46650	42251
SWSS-028	CT-09	46348	40255
SWSS-029	CT-09	46349	40550
SWSS-030	CT-09	46349	40851
SWSS-031	CT-09	46348	41151
SWSS-032	CT-09	46349	41450
SWSS-033	CT-09	46352	41748
SWSS-034	CT-09	46352	42054
SWSS-035C	CT-09	46353	42354
SWSS-036	CT-09	46350	42246
SWSS-037	CT-09	46046	40246
SWSS-038	CT-09	46053	40552
SWSS-039B	CT-09	46049	40847
SWSS-040	CT-09	46049	41150
SWSS-041	CT-09	46050	41451

SWSS-042	CT-09	46051	41749
SWSS-043	CT-09	46042	42052
SWSS-044	CT-09	46050	42353
SWSS-045	CT-09	46049	42251
SWSS-046	CT-09	45748	40251
SWSS-047	CT-09	45752	40546
SWSS-048	CT-09	45749	40845
SWSS-049	CT-09	45756	41146
SWSS-050	CT-09	45748	41449
SWSS-051	CT-09	45752	41745
SWSS-052	CT-09	45753	42049
SWSS-053	CT-09	45750	42353
SWSS-054	CT-09	45753	42249
SWSS-055	CT-09	45451	40245
SWSS-056	CT-09	45452	40547
SWSS-057	CT-09	45453	40850
SWSS-058	CT-09	45446	41150
SWSS-059	CT-09	45446	41445
SWSS-060B	CT-09	45453	41755
SWSS-061	CT-09	45447	42043
SWSS-062	CT-09	45449	42348
SWSS-063	CT-09	45452	42246
SWSS-064	CT-09	45148	40251
SWSS-065	CT-09	45154	40552
SWSS-066	CT-09	45154	40848
SWSS-067	CT-09	45148	41149
SWSS-068	CT-09	45146	41446
SWSS-069B	CT-09	45155	41745
SWSS-070	CT-09	45152	42053
SWSS-071	CT-09	45152	42349
SWSS-072	CT-09	45148	42252
SWSS-073	CT-09	44849	40251
SWSS-074	CT-09	44851	40551
SWSS-075	CT-09	44852	40849
SWSS-076	CT-09	44851	41151
SWSS-077	CT-09	44853	41450
SWSS-078	CT-09	44846	41750
SWSS-079	CT-09	44857	42046
SWSS-080C	CT-09	44848	42348
SWSS-081	CT-09	44855	42250
SWSS-082	CT-09	44553	40247
SWSS-083	CT-09	44553	40547
SWSS-084B	CT-09	44549	40848
SWSS-085	CT-09	44549	41149
SWSS-086	CT-09	44548	41447
SWSS-087	CT-09	44555	41745
SWSS-088	CT-09	44552	42048

SWSS-089	CT-09	44556	42351
SWSS-090	CT-09	44549	42248
SWSS-18-080	Sample	46887	42139
SWSS-18-090	Sample	45627	40481
SWSS-18-092	Sample	43945	41208

Mildred Lake - EIP 2018 Testing Locations			
Test Hole ID	**Test Type**	**Northing (MM)**	**Easting (MM)**
SEP-18-01	GCPTu	46830	52734
SEP-18-02	GCPTu	46928	52894
SEP-18-03B	GCPTu	47069	53083
SEP-18-04	GCPTu	46640	52670
SEP-18-05	GCPTu	46686	52818
SEP-18-06	GCPTu	46756	52965
SEP-18-07	GCPTu	46824	53152
SEP-18-08	GCPTu	46893	53316
SEP-18-09	GCPTu	46493	52755
SEP-18-10B	GCPTu	46557	52895
SEP-18-11	GCPTu	46592	53065
SEP-18-12	GCPTu	46633	53232
SEP-18-13B	GCPTu	46323	52856
SEP-18-14	GCPTu	46407	52998
SEP-18-15	GCPTu	46486	53298
SEP-18-01	Sample	46829	52733
SEP-18-04	Sample	46637	52671
SEP-18-05	Sample	46685	52820
SEP-18-06	Sample	46755	52965
SEP-18-07	Sample	46825	53153
SEP-18-10	Sample	46558	52896

Mildred Lake - SWIP Major 2018 Testing Locations			
Test Hole ID	**Test Type**	**Northing (MM)**	**Easting (MM)**
SWIPM-18-013	GCPTu	46467	47623
SWIPM-18-015	GCPTu	46149	47635
SWIPM-18-026	GCPTu	47467	47513
SWIPM-18-038	GCPTu	46672	47325
SWIPM-18-040	GCPTu	46421	46776
SWIPM-004	CT-09	45819	46676
SWIPM-005	CT-09	45822	46804
SWIPM-011B	CT-09	45931	46686
SWIPM-012	CT-09	45893	46825
SWIPM-013	CT-09	45872	46971
SWIPM-019	CT-09	46121	46581
SWIPM-020	CT-09	46081	46726
SWIPM-021	CT-09	46031	46865
SWIPM-022	CT-09	45994	47008
SWIPM-023	CT-09	45947	47153
SWIPM-024	CT-09	45938	47311
SWIPM-029	CT-09	46310	46479
SWIPM-030	CT-09	46266	46624
SWIPM-031	CT-09	46223	46772
SWIPM-032	CT-09	46173	46912
SWIPM-033	CT-09	46136	47054
SWIPM-034	CT-09	46092	47200
SWIPM-035	CT-09	46044	47340
SWIPM-036	CT-09	46002	47485
SWIPM-040	CT-09	46486	46429
SWIPM-041	CT-09	46456	46524
SWIPM-042	CT-09	46406	46666
SWIPM-043	CT-09	46368	46812
SWIPM-044	CT-09	46323	46954
SWIPM-045	CT-09	46278	47104
SWIPM-046	CT-09	46233	47245
SWIPM-047	CT-09	46191	47386
SWIPM-048	CT-09	46148	47529
SWIPM-049	CT-09	46102	47675
SWIPM-050B	CT-09	46115	47795
SWIPM-051	CT-09	46641	46422
SWIPM-052	CT-09	46600	46570
SWIPM-053	CT-09	46553	46712
SWIPM-054	CT-09	46510	46853
SWIPM-055	CT-09	46467	46998
SWIPM-056	CT-09	46420	47140
SWIPM-057	CT-09	46378	47292
SWIPM-058	CT-09	46330	47427
SWIPM-059	CT-09	46293	47574

SWIPM-060	CT-09	46247	47714
SWIPM-061	CT-09	46215	47823
SWIPM-062	CT-09	46794	46465
SWIPM-063	CT-09	46740	46613
SWIPM-064	CT-09	46701	46753
SWIPM-065	CT-09	46654	46899
SWIPM-066	CT-09	46614	47043
SWIPM-067	CT-09	46559	47187
SWIPM-068	CT-09	46525	47333
SWIPM-069	CT-09	46480	47474
SWIPM-070	CT-09	46434	47617
SWIPM-071	CT-09	46389	47759
SWIPM-072	CT-09	46348	47902
SWIPM-073	CT-09	46921	46549
SWIPM-074	CT-09	46887	46657
SWIPM-075	CT-09	46843	46798
SWIPM-076B	CT-09	46797	46942
SWIPM-077	CT-09	46747	47085
SWIPM-078	CT-09	46708	47227
SWIPM-079	CT-09	46665	47373
SWIPM-080	CT-09	46620	47520
SWIPM-081	CT-09	46582	47659
SWIPM-082	CT-09	46534	47804
SWIPM-083	CT-09	46512	47899
SWIPM-084	CT-09	47029	46695
SWIPM-085	CT-09	46988	46843
SWIPM-086B	CT-09	46938	46985
SWIPM-087	CT-09	46893	47134
SWIPM-088	CT-09	46849	47272
SWIPM-089	CT-09	46806	47421
SWIPM-090	CT-09	46764	47564
SWIPM-091	CT-09	46729	47706
SWIPM-092	CT-09	46681	47844
SWIPM-093	CT-09	46643	47998
SWIPM-094B	CT-09	47142	46757
SWIPM-095B	CT-09	47127	46886
SWIPM-096	CT-09	47086	47029
SWIPM-097	CT-09	47042	47172
SWIPM-098	CT-09	46988	47320
SWIPM-099	CT-09	46953	47459
SWIPM-100	CT-09	46910	47604
SWIPM-101	CT-09	46864	47743
SWIPM-102	CT-09	46824	47898
SWIPM-103	CT-09	46784	48030
SWIPM-104	CT-09	47266	46932
SWIPM-105	CT-09	47227	47073
SWIPM-106	CT-09	47181	47215

SWIPM-107	CT-09	47137	47358
SWIPM-108	CT-09	47102	47503
SWIPM-109	CT-09	47056	47645
SWIPM-110	CT-09	47010	47793
SWIPM-111C	CT-09	46963	47930
SWIPM-112	CT-09	46916	48080
SWIPM-113	CT-09	46853	48182
SWIPM-114	CT-09	47419	46973
SWIPM-115	CT-09	47331	47065
SWIPM-116	CT-09	47328	47259
SWIPM-117	CT-09	47285	47403
SWIPM-118	CT-09	47242	47547
SWIPM-119	CT-09	47196	47690
SWIPM-120	CT-09	47153	47833
SWIPM-121B	CT-09	47103	47977
SWIPM-122	CT-09	47068	48116
SWIPM-124	CT-09	47532	47165
SWIPM-125	CT-09	47470	47302
SWIPM-126	CT-09	47428	47443
SWIPM-127	CT-09	47382	47589
SWIPM-128	CT-09	47337	47732
SWIPM-129	CT-09	47295	47872
SWIPM-130B	CT-09	47250	48028
SWIPM-133	CT-09	47677	47116
SWIPM-134	CT-09	47656	47208
SWIPM-135	CT-09	47614	47350
SWIPM-136	CT-09	47567	47488
SWIPM-137	CT-09	47525	47631
SWIPM-138	CT-09	47485	47780
SWIPM-139	CT-09	47441	47920
SWIPM-140	CT-09	47411	48037
SWIPM-143	CT-09	47843	47108
SWIPM-144	CT-09	47799	47243
SWIPM-145	CT-09	47758	47396
SWIPM-146	CT-09	47715	47532
SWIPM-147	CT-09	47673	47675
SWIPM-148	CT-09	47626	47821
SWIPM-149C	CT-09	47582	47964
SWIPM-150	CT-09	47543	48111
SWIPM-153B	CT-09	47985	47147
SWIPM-154B	CT-09	47943	47292
SWIPM-155B	CT-09	47900	47440
SWIPM-156B	CT-09	47858	47574
SWIPM-157D	CT-09	47807	47719
SWIPM-158E	CT-09	47768	47867
SWIPM-159	CT-09	47724	48011
SWIPM-160B	CT-09	47692	48152

SWIPM-163B	CT-09	48130	47201
SWIPM-164	CT-09	48074	47376
SWIPM-165	CT-09	48046	47481
SWIPM-166B	CT-09	47998	47622
SWIPM-167	CT-09	47963	47765
SWIPM-168	CT-09	47914	47909
SWIPM-169B	CT-09	47864	48052
SWIPM-170	CT-09	47825	48198
SWIPM-172	CT-09	48231	47373
SWIPM-173	CT-09	48186	47520
SWIPM-174	CT-09	48148	47665
SWIPM-175	CT-09	48097	47802
SWIPM-176	CT-09	48053	47954
SWIPM-177	CT-09	48009	48095
SWIPM-179	CT-09	48376	47418
SWIPM-180	CT-09	48331	47559
SWIPM-181	CT-09	48295	47711
SWIPM-182	CT-09	48250	47849
SWIPM-183B	CT-09	48199	47994
SWIPM-184	CT-09	48133	48134
SWIPM-185	CT-09	48429	47755
SWIPM-186	CT-09	48388	47892
SWIPM-18-022	Sample	47749	47599
SWIPM-18-032	Sample	47055	47459
SWIPM-18-033	Sample	46994	46996
SWIPM-18-035	Sample	46812	47859
SWIPM-18-220	Sample	46130	46998

Mildred Lake - NMSPW Major 2018 Testing Locations			
Test Hole ID	Test Type	Northing (MM)	Easting (MM)
NMSPW-18-23	GCPTu	52174	43212
NMSPW-18-29	GCPTu	52095	42797
NMSPW-18-30	GCPTu	51693	43776
NMSPW-18-32	GCPTu	51629	43231
NMSPW-18-34	GCPTu	51675	42514
NMSPW-18-37	GCPTu	51231	43811
NMSPW-18-38	GCPTu	51201	43538
NMSPW-001	CT-09	51027	43682
NMSPW-002	CT-09	51074	43532
NMSPW-003	CT-09	51115	43396
NMSPW-004	CT-09	51153	43246
NMSPW-005B	CT-09	51201	43106
NMSPW-006	CT-09	51253	42957
NMSPW-007	CT-09	51287	42824
NMSPW-008	CT-09	51332	42668
NMSPW-009	CT-09	51382	42533
NMSPW-010	CT-09	51455	42418
NMSPW-011	CT-09	51112	43826
NMSPW-012	CT-09	51173	43730
NMSPW-013	CT-09	51218	43576
NMSPW-014	CT-09	51261	43436
NMSPW-015	CT-09	51302	43290
NMSPW-016	CT-09	51345	43154
NMSPW-017	CT-09	51393	43005
NMSPW-018	CT-09	51435	42867
NMSPW-019	CT-09	51483	42709
NMSPW-020	CT-09	51530	42570
NMSPW-021	CT-09	51562	42429
NMSPW-022	CT-09	51629	42298
NMSPW-023	CT-09	51288	43857
NMSPW-024	CT-09	51316	43777
NMSPW-025	CT-09	51363	43622
NMSPW-026	CT-09	51401	43484
NMSPW-027	CT-09	51444	43334
NMSPW-028B	CT-09	51484	43195
NMSPW-029	CT-09	51537	43046
NMSPW-030	CT-09	51568	42909
NMSPW-031	CT-09	51616	42759
NMSPW-032	CT-09	51670	42617
NMSPW-033B	CT-09	51707	42464
NMSPW-034	CT-09	51753	42332
NMSPW-035	CT-09	51424	43926
NMSPW-036	CT-09	51461	43811
NMSPW-037	CT-09	51504	43663

NMSPW-038	CT-09	51547	43525
NMSPW-039	CT-09	51592	43377
NMSPW-040	CT-09	51630	43240
NMSPW-041	CT-09	51682	43091
NMSPW-042	CT-09	51716	42952
NMSPW-043	CT-09	51760	42806
NMSPW-044	CT-09	51805	42659
NMSPW-045	CT-09	51855	42516
NMSPW-046	CT-09	51890	42373
NMSPW-047B	CT-09	51558	43997
NMSPW-048	CT-09	51604	43864
NMSPW-049	CT-09	51651	43712
NMSPW-050	CT-09	51689	43569
NMSPW-051	CT-09	51738	43421
NMSPW-052	CT-09	51773	43285
NMSPW-053	CT-09	51823	43133
NMSPW-054	CT-09	51858	42992
NMSPW-055	CT-09	51907	42844
NMSPW-056	CT-09	51955	42703
NMSPW-057	CT-09	51998	42559
NMSPW-058	CT-09	52031	42413
NMSPW-059	CT-09	51736	43901
NMSPW-060	CT-09	51797	43753
NMSPW-061	CT-09	51833	43612
NMSPW-062	CT-09	51880	43466
NMSPW-063	CT-09	51915	43329
NMSPW-064	CT-09	51966	43180
NMSPW-065	CT-09	52013	43036
NMSPW-066	CT-09	52049	42893
NMSPW-067	CT-09	52094	42753
NMSPW-068	CT-09	52141	42607
NMSPW-069	CT-09	51884	43939
NMSPW-070	CT-09	51929	43800
NMSPW-071	CT-09	51976	43653
NMSPW-072B	CT-09	52021	43511
NMSPW-073B	CT-09	52065	43366
NMSPW-074	CT-09	52109	43223
NMSPW-075	CT-09	52154	43082
NMSPW-076	CT-09	52190	42945
NMSPW-077	CT-09	52243	42784
NMSPW-078	CT-09	52022	43988
NMSPW-079	CT-09	52080	43841
NMSPW-080	CT-09	52133	43702
NMSPW-081	CT-09	52168	43557
NMSPW-082	CT-09	52209	43414
NMSPW-083	CT-09	52261	43266
NMSPW-084	CT-09	52292	43128

NMSPW-085	CT-09	52337	42979
NMSPW-086B	CT-09	52387	42832
NMSPW-087	CT-09	52177	44032
NMSPW-088	CT-09	52226	43887
NMSPW-089	CT-09	52268	43743
NMSPW-090	CT-09	52311	43596
NMSPW-091	CT-09	52354	43442
NMSPW-092	CT-09	52400	43308
NMSPW-093B	CT-09	52434	43170
NMSPW-094	CT-09	52486	43020
NMSPW-095	CT-09	52360	43923
NMSPW-096	CT-09	52408	43781
NMSPW-097B	CT-09	52451	43639
NMSPW-098	CT-09	52497	43495
NMSPW-099	CT-09	52539	43354
NMSPW-100	CT-09	52541	43220
NMSPW-101	CT-09	51696	44040
NMSPW-102	CT-09	51850	44083
NMSPW-103	CT-09	51985	44136
NMSPW-104	CT-09	51841	44249
NMSPW-18-23	Sample	52171	43210
NMSPW-18-25	Sample	51910	43312
NMSPW-18-26	Sample	51913	43615
NMSPW-18-31	Sample	51843	42858
NMSPW-18-33	Sample	51470	43561
NMSPW-18-34	Sample	51676	42514
NMSPW-18-35	Sample	51405	42965

Mildred Lake - NMSPE 2018 Testing Locations			
Test Hole ID	**Test Type**	**Northing (MM)**	**Easting (MM)**
NMSPE-18-07	GCPTu	51775	46369
NMSPE-18-08	GCPTu	51624	46886
NMSPE-18-09	GCPTu	51406	46692
NMSPE-18-10	GCPTu	51405	47179
NMSPE-18-13	GCPTu	51394	46979
NMSPE-18-15	GCPTu	51175	47336
NMSPE-18-16	GCPTu	51619	46620
NMSPE-18-17	GCPTu	51665	47152
NMSPE-001	CT-09	50361	47235
NMSPE-002	CT-09	50335	47342
NMSPE-003	CT-09	50487	47171
NMSPE-004	CT-09	50462	47279
NMSPE-005	CT-09	50428	47365
NMSPE-006	CT-09	50404	47465
NMSPE-007	CT-09	50376	47560
NMSPE-008	CT-09	51224	45108
NMSPE-009	CT-09	51197	45189
NMSPE-010	CT-09	50607	47123
NMSPE-011	CT-09	50583	47197
NMSPE-012	CT-09	50555	47294
NMSPE-013B	CT-09	50525	47389
NMSPE-014	CT-09	50497	47485
NMSPE-015B	CT-09	50472	47585
NMSPE-016	CT-09	51378	44933
NMSPE-017	CT-09	51345	45033
NMSPE-018B	CT-09	51309	45133
NMSPE-019	CT-09	51295	45212
NMSPE-020	CT-09	51258	45323
NMSPE-021	CT-09	51247	45415
NMSPE-022	CT-09	50714	47133
NMSPE-023	CT-09	50685	47235
NMSPE-024	CT-09	50651	47334
NMSPE-025	CT-09	50625	47425
NMSPE-026	CT-09	50599	47522
NMSPE-027	CT-09	50566	47613
NMSPE-028	CT-09	51530	44775
NMSPE-029	CT-09	51499	44869
NMSPE-030	CT-09	51477	44960
NMSPE-031B	CT-09	51439	45059
NMSPE-032	CT-09	51405	45158
NMSPE-033	CT-09	51384	45256
NMSPE-034C	CT-09	51353	45349
NMSPE-035B	CT-09	51335	45440
NMSPE-036	CT-09	51294	45542

NMSPE-037	CT-09	51289	45632
NMSPE-038	CT-09	50831	47066
NMSPE-039	CT-09	50802	47159
NMSPE-040	CT-09	50774	47255
NMSPE-041	CT-09	50746	47348
NMSPE-042	CT-09	50716	47451
NMSPE-043	CT-09	50695	47541
NMSPE-044	CT-09	51572	44989
NMSPE-045	CT-09	51543	45085
NMSPE-046	CT-09	51512	45180
NMSPE-047	CT-09	51492	45281
NMSPE-048	CT-09	51446	45377
NMSPE-049	CT-09	51428	45469
NMSPE-050	CT-09	51393	45573
NMSPE-051	CT-09	51361	45670
NMSPE-052	CT-09	51343	45763
NMSPE-053B	CT-09	51316	45865
NMSPE-054	CT-09	51291	45958
NMSPE-055	CT-09	51001	46904
NMSPE-056	CT-09	50961	47001
NMSPE-057	CT-09	50937	47095
NMSPE-058	CT-09	50902	47204
NMSPE-059	CT-09	50872	47295
NMSPE-060	CT-09	50843	47392
NMSPE-061	CT-09	50817	47489
NMSPE-062	CT-09	50806	47540
NMSPE-063	CT-09	51608	45208
NMSPE-064B	CT-09	51581	45303
NMSPE-065	CT-09	51551	45412
NMSPE-066	CT-09	51523	45499
NMSPE-067	CT-09	51483	45600
NMSPE-068	CT-09	51456	45694
NMSPE-069	CT-09	51431	45785
NMSPE-070	CT-09	51397	45887
NMSPE-071	CT-09	51368	45980
NMSPE-072	CT-09	51340	46076
NMSPE-073	CT-09	51314	46174
NMSPE-074	CT-09	51285	46262
NMSPE-075	CT-09	51253	46357
NMSPE-076	CT-09	51225	46465
NMSPE-077	CT-09	51195	46559
NMSPE-078	CT-09	51162	46651
NMSPE-079	CT-09	51137	46743
NMSPE-080B	CT-09	51119	46837
NMSPE-081	CT-09	51083	46940
NMSPE-082	CT-09	51052	47030
NMSPE-083	CT-09	51024	47125

NMSPE-084	CT-09	51004	47235
NMSPE-085	CT-09	50965	47312
NMSPE-086	CT-09	50941	47411
NMSPE-087	CT-09	50912	47507
NMSPE-088	CT-09	51615	45528
NMSPE-089	CT-09	51582	45629
NMSPE-090	CT-09	51555	45726
NMSPE-091	CT-09	51524	45826
NMSPE-092	CT-09	51502	45924
NMSPE-093	CT-09	51474	46013
NMSPE-094	CT-09	51437	46113
NMSPE-095	CT-09	51415	46201
NMSPE-096	CT-09	51386	46299
NMSPE-097	CT-09	51351	46398
NMSPE-098	CT-09	51326	46497
NMSPE-099	CT-09	51302	46591
NMSPE-100	CT-09	51261	46683
NMSPE-101	CT-09	51236	46783
NMSPE-102	CT-09	51208	46876
NMSPE-103	CT-09	51172	46966
NMSPE-104	CT-09	51149	47052
NMSPE-105	CT-09	51113	47152
NMSPE-106	CT-09	51087	47248
NMSPE-107	CT-09	51062	47342
NMSPE-108	CT-09	51029	47445
NMSPE-109	CT-09	51009	47534
NMSPE-110	CT-09	51664	45634
NMSPE-111	CT-09	51649	45743
NMSPE-112	CT-09	51629	45843
NMSPE-113	CT-09	51593	45944
NMSPE-114	CT-09	51565	46046
NMSPE-115	CT-09	51542	46133
NMSPE-116	CT-09	51514	46232
NMSPE-117	CT-09	51489	46333
NMSPE-118	CT-09	51451	46440
NMSPE-119	CT-09	51424	46525
NMSPE-120	CT-09	51391	46624
NMSPE-121	CT-09	51363	46722
NMSPE-122	CT-09	51338	46805
NMSPE-123	CT-09	51309	46907
NMSPE-124	CT-09	51274	46972
NMSPE-125	CT-09	51252	47094
NMSPE-126	CT-09	51220	47192
NMSPE-127	CT-09	51190	47286
NMSPE-128	CT-09	51168	47384
NMSPE-129	CT-09	51136	47476
NMSPE-130	CT-09	51102	47572

NMSPE-131	CT-09	51672	46003
NMSPE-132B	CT-09	51666	46064
NMSPE-133	CT-09	51632	46161
NMSPE-134	CT-09	51601	46259
NMSPE-135	CT-09	51571	46356
NMSPE-136	CT-09	51545	46449
NMSPE-137	CT-09	51513	46545
NMSPE-138	CT-09	51486	46641
NMSPE-139	CT-09	51459	46733
NMSPE-140B	CT-09	51424	46832
NMSPE-141	CT-09	51402	46923
NMSPE-142	CT-09	51373	47020
NMSPE-143B	CT-09	51349	47121
NMSPE-144	CT-09	51311	47210
NMSPE-145	CT-09	51284	47310
NMSPE-146B	CT-09	51254	47404
NMSPE-147C	CT-09	51225	47506
NMSPE-148	CT-09	51779	46021
NMSPE-149	CT-09	51752	46090
NMSPE-150	CT-09	51719	46193
NMSPE-151	CT-09	51695	46284
NMSPE-152	CT-09	51670	46381
NMSPE-153	CT-09	51641	46480
NMSPE-154	CT-09	51614	46578
NMSPE-155B	CT-09	51580	46672
NMSPE-156	CT-09	51555	46768
NMSPE-157	CT-09	51525	46871
NMSPE-158	CT-09	51498	46963
NMSPE-159	CT-09	51468	47059
NMSPE-160	CT-09	51435	47151
NMSPE-161	CT-09	51409	47251
NMSPE-162	CT-09	51387	47336
NMSPE-163B	CT-09	51348	47434
NMSPE-164	CT-09	51324	47529
NMSPE-165	CT-09	51916	45882
NMSPE-166	CT-09	51910	45934
NMSPE-167	CT-09	51892	46028
NMSPE-168	CT-09	51855	46123
NMSPE-169	CT-09	51819	46216
NMSPE-170	CT-09	51792	46324
NMSPE-171	CT-09	51775	46405
NMSPE-172	CT-09	51745	46501
NMSPE-173	CT-09	51706	46606
NMSPE-174B	CT-09	51676	46701
NMSPE-175	CT-09	51644	46801
NMSPE-176	CT-09	51620	46893
NMSPE-177	CT-09	51594	46985

NMSPE-178B	CT-09	51556	47081
NMSPE-179	CT-09	51533	47177
NMSPE-180	CT-09	51508	47279
NMSPE-181	CT-09	51479	47369
NMSPE-182B	CT-09	51442	47466
NMSPE-183	CT-09	51370	47549
NMSPE-185	CT-09	52012	45857
NMSPE-186	CT-09	52006	45963
NMSPE-187	CT-09	51965	46050
NMSPE-188	CT-09	51952	46153
NMSPE-189	CT-09	51924	46243
NMSPE-190	CT-09	51890	46346
NMSPE-191	CT-09	51864	46437
NMSPE-192	CT-09	51838	46532
NMSPE-193	CT-09	51806	46628
NMSPE-194B	CT-09	51778	46724
NMSPE-195	CT-09	51744	46825
NMSPE-196	CT-09	51719	46917
NMSPE-197	CT-09	51690	47016
NMSPE-198	CT-09	51658	47115
NMSPE-199	CT-09	51630	47211
NMSPE-200	CT-09	51602	47299
NMSPE-201	CT-09	51531	47390
NMSPE-206	CT-09	52045	46186
NMSPE-207	CT-09	52015	46281
NMSPE-208	CT-09	51991	46374
NMSPE-209	CT-09	51957	46472
NMSPE-210	CT-09	51924	46562
NMSPE-211	CT-09	51898	46662
NMSPE-212	CT-09	51868	46756
NMSPE-213	CT-09	51845	46851
NMSPE-214	CT-09	51816	46949
NMSPE-215	CT-09	51789	47050
NMSPE-216	CT-09	51755	47144
NMSPE-217	CT-09	51727	47240
NMSPE-220	CT-09	52074	46297
NMSPE-221	CT-09	52061	46402
NMSPE-222	CT-09	52025	46489
NMSPE-223	CT-09	52024	46598
NMSPE-224	CT-09	51973	46683
NMSPE-225	CT-09	51966	46784
NMSPE-226	CT-09	51939	46883
NMSPE-227	CT-09	51907	46981
NMSPE-228	CT-09	51877	47074
NMSPE-229	CT-09	51824	47162
NMSPE-236	CT-09	51613	45426
NMSPE-237	CT-09	50350	47639

NMSPE-18-08	Sample	51625	46890
NMSPE-18-09	Sample	51408	46698
NMSPE-18-11	Sample	51420	46208
NMSPE-18-12	Sample	50645	47415
NMSPE-18-13	Sample	51389	46987
NMSPE-18-15	Sample	51182	47336
NMSPE-18-16	Sample	51619	46620
NMSPE-18-17	Sample	51669	47144

Mildred Lake - NMSPE Deep Cake 2018 Testing Locations			
Test Hole ID	**Test Type**	**Northing (MM)**	**Easting (MM)**
Cake-18-A1-60E	GCPTu	51070	48095
Cake-18-A2	GCPTu	51070	47949
Cake-18-B1	GCPTu	50850	48237
Cake-18-B1-70W	GCPTu	50864	48172
Cake-18-B2	GCPTu	50842	48270
Cake-18-C2	GCPTu	51300	48195
Cake-18-A1-60E	Sample	51071	48096
Cake-18-A2	Sample	51070	47950
Cake-18-B1	Sample	50848	48237
Cake-18-B1-70W	Sample	50863	48172
Cake-18-B2	Sample	50843	48268
Cake-18-C2	Sample	51301	48195